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Cockpit Resource Management Training

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Cockpit Resource Management Training

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PREFACE

Cockpit Resource Management Training is a relatively new concept in the aviation industry. Although it is still in the process of maturing, it has received widespread acceptance in all facets of the community, worldwide.

NASA sponsored the first workshop on this subject in 1979. That workshop was a direct outgrowth of research begun in the mid-seventies at the NASA-Ames Research Center's Man-Vehicle Systems Research Division (now the Aerospace Human Factors Research Division). This work, under the leadership of Drs. Charles E. Billings and John K. Lauber along with George E. Cooper, Ames' former Chief Test Pilot, was aimed at addressing some of the more perplexing problems underlying so-called "pilot error" accidents that seemed to account for an unusually large percentage of the total. One of the early observations of this research was that many of these problems had nothing to do with "stick-and-rudder" skills, but seemed to be related to other areas, such as decision-making, crew coordination, command, leadership, and communications skills. Another observation was that pilot training programs scarcely touched upon these concepts.

These early observations were graphically confirmed in the first "full-mission simulation" study conducted by a NASA/Industry research team led by noted British aviation researcher, the late Dr. Hugh Patrick Ruffell Smith, who at the time was a guest investigator at Ames. Ruffell Smith and colleagues discovered, to their surprise, that the vast majority of pilot performance problems were due to a failure, on the part of all cockpit crewmembers, to utilize resources which were readily available to them. This led to the identification of skills related to "cockpit resource management" and the notion that training programs should address these areas.

The 1979 workshop included presentations from a broad spectrum of the industry and stimulated the development of a number of training programs. The proceedings document of that workshop (Cooper, White, & Lauber, 1979; NASA Conference Publication 2120) has sometimes been referred to as "the bible" of Cockpit Resource Management Training. Much has happened in this area since 1979, and NASA-Ames' Aerospace Human Factors Research Division has received many requests over the years to sponsor a new workshop to review the progress that has been made. The U.S. Air Force Military Airlift Command, having undertaken resource management training on a large scale, also urged a comprehensive review and agreed to co-sponsor this workshop.

This volume is an up-to-date reference for use by those interested in the subject of Cockpit Resource Management Training. It is a complete proceedings of the new workshop and intended to be the "new testament" for this important training concept.

H. Clayton Foushee
Harry W. Orlady

INTRODUCTION TO THE WORKSHOP

Dr. H. Clayton Foushee, Workshop Co-Chair
NASA-Ames Research Center

Maj. Edward Aufderheide, Workshop Co-Chair
Headquarters, Military Airlift Command

DR. FOUSHEE: It is a pleasure to welcome you to San Francisco and to the NASA/MAC Workshop on Cockpit Resource Management Training. I'd like to take the next few minutes to review the objectives of the workshop and what we hope to accomplish over the next three days. We have been fortunate to line up an impressive group of speakers, and there are about 200 representatives here from approximately 80 organizations representing 14 countries. The first CRM Workshop NASA sponsored in 1979 had around 70 attendees from 32 organizations representing 9 countries, so clearly the level of interest has dramatically increased. We also have here a very good cross-section of the community. The last time I checked, 20% of the attendees were representatives of major U.S. air carriers; 10% non U.S. carriers; 31% representing the military; 10% regional and corporate operations; 7% government (non-military); 10% representing training companies; and 12% representing a broad spectrum including the academic community, trade associations, etc. This turnout is a testament to the interest in this topic, but it also provides us with a unique opportunity to carefully examine what we are doing and what we could be doing with CRM Training. We have gathered here most of the world's experts in this area, and we have worked very hard to organize a framework for this workshop so that the training world can benefit from your collective expertise.

The primary objective of this workshop is to review the progress that has been made in this area over the last several years and to determine what we are doing well and what should be improved. It is important that you approach most of what you'll hear and discuss over the next few days from a critical perspective. Most of us believe in the importance of coordinated crew performance and training that facilitates this aim, so we're not here to "sell" the concept. CRM is now largely an accepted concept in aircrew training. What we are here to do is to take a very hard look at how we are now conducting CRM Training and to use this review as a means of maximizing our efforts in this area. Each of the presentations in the general session has been carefully selected to provide you with the tools to go about this review process, and hopefully you will arm yourself with ideas for your working group discussions. As you will see, various organizations are approaching training in this area from different perspectives, which is as it should be. There is no single correct approach. But, as you listen to the presentations of various programs, think critically about them and the areas they seek to address.

There are four major questions that this workshop has been organized to focus upon, so it would help if you would keep these in mind during the presentations, and you'll hear more about these questions as we go into the working group process starting tomorrow afternoon:

1) What are the essential elements of an optimal CRM Training program? What are the topic areas that should be covered? What is it exactly that we are trying to train? Can CRM Training possibly hope to be effective in all of the topic areas you'll hear about?

2) What are the strengths and weaknesses of current approaches to CRM Training? Are there areas where CRM is doing a good job and areas where it is not suited? Are our techniques adequate for what we are trying to accomplish? Keep issues such as these in mind during the presentations and during your working group deliberations.

3) How can CRM Training best be implemented, and do any barriers exist? As you will see, there are many different approaches to CRM implementation, and while there may be no single best way, there are probably some ways that are more successful than others. Some have sought to implement CRM under existing FARs, while others have sought exemptions. Some utilize classroom approaches, others group exercises, others simulator training, or some combination of all. Some incorporate CRM into Captain Upgrade Training, others as part of Recurrent Training, and still others as a "special" training area not addressed in "standard" or "traditional" training. Some feel that CRM can't be effectively addressed under current FAR's, while others are satisfied with the current system. These are the types of issues to keep in mind. But, regulations aren't the only possible barriers. The climate within your own organizations must be conducive to effective training in this area, otherwise you're fighting an uphill battle that will be hard to win.

4) Is CRM Training effective, how do we know, or how should we find out? This may be the most difficult question of all, but if we are to be maximally effective, we must ultimately tackle this difficult issue. The FAA, with its responsibility to ensure that crewmembers are qualified and the aviation system safe, can't ignore this question, and neither can those training managers responsible to their companies for managing their training funds wisely.

Hopefully, a product of this workshop will be guidelines that address these questions. As you will later see, the working groups have been organized accordingly to address these issues. I'll have more to say about the working group process and the subject areas, before we break into the groups tomorrow afternoon.

At this time, I would like to introduce my co-chair, Maj. Ed Aufderheide for some introductory remarks.

MAJ. AUFDERHEIDE: On behalf of General Cassidy, Commander-in-Chief of the Military Airlift Command, I'd like to welcome all of you to this meeting, and I share Clay's enthusiasm because this group is a testament to the acceptance of this training concept. MAC has been working in CRM training as a broad concept for a number of years. In the last couple of years, we have begun to implement it as a specific block of instruction. In searching for new ideas, we have had numerous opportunities to interact with various industry sources both civil and military and the exchange of information has been exceptional. They have all been more than willing to share the ideas that have

been developed for their own particular organizations, and we have seen, as Clay mentioned, the approaches are extremely varied. Some programs occur over several days, while others are smaller blocks within larger programs.

MAC held a workshop within the Command last August, to which we invited some of our friends from the private sector, and we found a tremendous amount of enthusiasm for the training concept. At this meeting, we spent about 50% of our time educating and 50% dealing with program development issues, and we felt there would be some benefit to getting all interested parties together on a larger scale for a discussion of the issues. It is in the spirit of information exchange that we decided to co-sponsor this meeting.

We have all branches of the service represented, and within the Air Force, we have all of our major commands here--Tactical, Strategic, and Airlift. We're concerned about the single-seat guy as well as the multi-pilot crew. This interest is very strong at the high command level. General Ryan, who was our Commander-in-Chief until early last year, was a strong supporter of the program. He directed its implementation for the C-130 in particular. Since then the concept has been expanding to all weapons systems. General Cassidy has recently returned to MAC as Commander and has been in the field interacting with our training people. He has spent considerable time on the C-5 contract training program, and is strongly in support of the program. Although he is not able to be with us, he has sent his representative, General Donald D. Brown, who will be addressing us tomorrow morning. General Brown is the Commander of the 22nd Air Force based at Travis AFB.

I would once again like to encourage you to be open at this forum and to get the creative juices flowing. In the next three days, I think we have a chance to make major contributions to aviation training and safety. With that, I'll turn the forum over to Clay, who will conduct today's proceedings.

DR. FOUSHEE: A few administrative details before we get started. You'll notice we have a very tight schedule on the agenda in order to accommodate the number of presentations we felt should be heard, so we'll have to stick very closely to it. The speakers have been informed that they should leave time for questions and answers at the end of their presentations, but most of the general discussion may have to wait for the working groups. You'll also notice that we have a court reporter here to document all of the presentations and discussion, so when you have a question or comment, please use a microphone, talk clearly, and be sure to identify yourself and your organization for the court reporter. We will be publishing the entire proceedings of the workshop; including presentations, discussion, and working group reports; but in order to do this the court reporter needs to hear clearly.

If you haven't already done so, please pay your registration fee. Our U.S. colleagues will understand what I mean when I say that Gramm-Rudman hasn't allowed NASA and MAC to totally underwrite this meeting. We did as much as we could, but these meeting facilities, audio-visual equipment, microphones, and even the limited refreshments provided at breaks, don't come cheap. I think they're also charging us for the air we breathe in these rooms, so don't use too much. The $10 per person was based on everyone in attendance paying, otherwise Ed and I are going to have substantially

smaller paychecks next month, when the hotel bills us for these facilities. You can see Harry Orlady, or any of the NASA people who'll take good care of your money.

Again, welcome, be prepared to work hard, and let's have a very productive meeting.

COCKPIT RESOURCE MANAGEMENT: BACKGROUND AND OVERVIEW

Hon. John K. Lauber, Member
National Transportation Safety Board

INTRODUCTION

Good morning and welcome. I am delighted to be here with you this morning and honored that Dr. Foushee extended the invitation to me to present this keynote address on a topic which most of you know is one in which I have had a long-standing interest. Many of you were present nearly seven years ago when we met in this same hotel to discuss "Resource Management on the Flight Deck." Since that time, there have been literally hundreds of symposia, papers, workshops, and, most importantly, actual training programs devoted to the concept of cockpit resource management and ways to effectively implement the concept in real-world flight operations. Since then, too, there have been major changes in aviation; some because of new technology, and some because of economic and political developments, most notably, deregulation. All of these changes have major implications for how we operate our aircraft and how we conduct flight crew training. Thus, it is highly appropriate that we meet here to take stock: to review the background and status of cockpit resource management training, and to consider where we go from here. In addition, it is a pleasure to welcome our colleagues from the USAF Military Airlift Command, and to work with them to develop pilot training programs which will meet their requirements. I hope this represents the beginning of many such opportunities.

My Ph.D. dissertation advisor was fond of saying that an idea, if new, is probably not very good, and, if good, is probably not very new. In other words, concepts take a long time to evolve into their mature state. Cockpit Resource Management (CRM) is a maturing concept, and I think it is safe to say that to the extent that it is a new idea, it needs much refinement, and to the extent that it is a good idea, it is not a new one. Our purpose over the next few days is to evaluate the concept--what it is (and isn't), what has been tried (and hasn't been tried), and what works (and doesn't work)--and to determine what we can do to further refine the idea to make the good parts even better. Our success in this venture will, of course, be measured by how successful we are in preventing accidents and incidents which stem from inadequate or ineffective cockpit resource management, examples of which I'll be discussing below.

Clay asked me to "set the stage" for the remainder of this workshop, much as I did in 1979 with my "Background and Statement of the Problem." So, in the time remaining, I would like to do just that. We'll start with a brief review of the history of the concept of CRM. Then I want to discuss some definitions and provide some examples of accidents and incidents which illustrate the concept. I'll briefly mention some of the programs which have been implemented to train cockpit resource management, and then conclude with a summary of the approach and objectives that Clay and his MAC colleagues have set out for this workshop. The objective of my talk

this morning is to provide you with some of the basic ideas and concepts you'll be using throughout the next few days as you work to produce the working group reports which are the true product of workshops like this one. As in 1979, I can only hope to stimulate you and to serve as a catalyst for the further refinements of a concept which is certainly not new and which I believe is a good one.

BACKGROUND AND HISTORY

For many of you, this review is hardly necessary since you are the people who made it happen. However, in the interest of making sure that we all start off on the same foot, I would like to spend a few minutes reviewing the recent history of the concept of Cockpit Resource Management. Like all views of history in which the historian has been directly involved in the issues at hand, this is likely to be myopic--I won't do justice to all the work which preceded the activities of which I have first-hand knowledge, and you'll simply have to bear in mind that terms like "cockpit coordination" and "total crew concept" represent the antecedents of CRM.

In our NASA human factors research program, we first became aware of some of the issues through a structured interview program that Charlie Billings, George Cooper and I conducted with line pilots. We were interested in hearing first-hand accounts of human factors issues in flight operations so that we could structure a meaningful research program to address some of the more perplexing problems which were the underlying factors causing so-called "pilot error" accidents. In exchange for confidentiality, we asked line pilots to discuss their perceptions and experiences with us. Although we couldn't be sure at the time whether these pilots would talk to us, we were quickly relieved to find that many were indeed willing to share their mistakes with us. This interview program was the direct antecedent of the Aviation Safety Reporting System, the highly successful incident reporting program which just a month ago celebrated its 10th birthday.

One consistent theme mentioned to us during these interviews was a dissatisfaction with pilot training programs. However, the concerns expressed by these pilots generally didn't have anything to do with the technical training being received, but rather concerned other skills like decision-making, command, leadership, and communications skills. We received these comments especially frequently from relatively new captains who were discovering that there is considerably more to being the pilot in command than simply possessing good stick and rudder skills, and who felt that they were not receiving adequate support, including training, during their transition from the right to the left seat. This was an important series of observations which later helped us identify some of the dimensions of what we now call cockpit resource management.

Another early source of information which we used was accident and incident reports from various sources. I know that most of you are familiar with the now classic L-1011 accident in the Everglades forest which happened when the flight crew became preoccupied with changing a burned-out nose landing gear indicator lamp. They failed to notice that the altitude hold function of the autopilot had been inadvertantly disengaged which eventually resulted in a crash in the swamp.

In the same month of the same year another accident occurred which also vividly demonstrated the importance of "minding the store." A B-737 crashed while attempting to go-around from a non-precision approach to Chicago's Midway airport. This accident happened because, earlier in the flight, the "flight data recorder inoperative" light illuminated, and the three-man cockpit crew became engrossed in the "problem." They lost track of where they were (or as Doug Schwartz will tell you later, they lost "situation awareness") and ended up trying to salvage the approach after crossing the final approach fix fast, high, and not configured for the landing. The pilot used speed brakes to help, but due to the extreme time pressure, forgot about them and then attempted to go around with them fully deployed.

George Cooper and Maury White did a major analysis of jet transport accidents which occurred between 1968 and 1976, and found more than 60 which involved problems with decision-making, leadership, pilot judgment, communications, and crew coordination (Cooper, White, and Lauber, 1980). Similar problems were seen in an analysis of incidents reported to the ASRS. Miles Murphy published the results of one such analysis in 1980, and helped establish several dimensions of the overall cockpit resource management problem (Murphy, 1980).

We used the lessons learned from these analyses extensively in formulating our ideas and in developing the concept of cockpit resource management. However, by far the most significant data came from the classic Ruffell Smith study (Ruffell Smith, 1979), and it was literally during this study that the idea of applying classical business management concepts to cockpit operations came to us. Those of you who are familiar with the Ruffell Smith study will remember that wide variations in the performance of volunteer B-747 line crews on a demanding, but realistic, full-mission simulation scenario were observed. It seemed to us that much of this performance variation could be attributed to the variable effectiveness of the pilots and flight engineers in utilizing available resources. Those who made effective, integrated use of cockpit resources performed well; those who did not display effective management skills also committed large numbers of operational and technical errors, some of which were potentially catastrophic, such as a 100,000 pound error in calculating the gross weight of the airplane for landing.

Subsequent analysis of the cockpit voice data from the Ruffell Smith study by Clay Foushee and Karen Manos (Foushee and Manos, 1981) shed further light on the issue and demonstrated that there is a direct correlation between measurable performance and the effectiveness of intracockpit communications. Clay and his co-workers have followed up on this aspect of cockpit resource management, and have some interesting and exciting data to report from a recent simulation study of fatigue and its effects upon performance in short-haul flight operations. Basically, they found that flying together for two or three days as a crew leads to a refinement in intracockpit communications skills which is sufficient to offset any adverse performance effects resulting from the cumulative fatigue effects of flying short-haul flight schedules. I believe this study provides a highly convincing demonstration of the viability of the CRM concept.

One other observation from the Ruffell Smith study is important to mention here. Although we had not set out to conduct a training study, it soon became apparent to all of us, including Wally Simons, the check airman who helped us run the study, that full-

mission simulation techniques may have great potential for flight crew training, especially for problems like crew coordination, cockpit communications, and decision-making. This was further reinforced by many unsolicited and unexpected comments from many of the subject pilots about their beliefs that the experience in the simulator was a great learning opportunity. Many commented that they wouldn't have believed that they were capable of committing the mistakes that they had in fact made, and that this insight was potentially of great benefit to them.

In approximately 1978, I was asked to present a progress report to the Air Transport Association's Flight Operations Committee in Chicago. Among other things, I talked about observations emerging from the Ruffell Smith study, and was asked by Roger Fleming if I was aware of work being done by Capt. Tom Nunn at Northwest Airlines in Minneapolis. On the basis of Roger's description of Tom's efforts to use full-mission simulation techniques in a training program called, at that time, CCT for Coordinated Crew Training, I made arrangements to visit Northwest. I was delighted to learn that even though Tom had started out with an entirely different set of objectives from those of the Ruffell Smith study, the approach taken to generating scenarios, and most importantly, the performance of line pilots flying those scenarios, were remarkably similar. It gave us added assurance that the observations we were making in the simulator were not unique to that simulator nor to the airline used for the study. Furthermore, that contact led to further collaboration between Capt. Nunn and his people at Northwest, and Mr. Richard Collie, then of the Air Transport Division at the FAA, and ourselves at NASA-Ames in the further development of full-mission training techniques now called LOFT, or Line-Oriented Flight Training, a term coined by Dick Collie.

About the same time, I first met Bob Helmreich, and I will never forget the enthusiastic reception Bob gave to our emergent ideas about how the problems we were seeing in these studies seemed to stem from insufficient skills in effective management of cockpit resources, and it was about this time that I first remember hearing and using the term cockpit resource management. Bob's many contributions to this area (including one of his very best in the form of a graduate student named Foushee) are well documented, and you'll be hearing about them next in the program.

Also about this time, George Cooper and Maury White suggested the idea of conducting a meeting on the general topic, and that such a meeting should be in the form of a workshop in which industry, university, FAA, DoD, NTSB and NASA personnel should outline the problem of cockpit resource management, identify what has already been done to solve some of these problems, and, most importantly, identify potential solutions to them. In June, 1979 we convened such a workshop in this hotel, and, I think, were quite successful in fostering the development of some innovative approaches to training cockpit resource management skills.

Perhaps the best example of an outgrowth of that workshop is the now well-known United Airlines Command, Leadership, and Resource Management (CLR) program. United had formed a working group to study flight safety and operational issues prior to the workshop, but I am told by several of the key United people involved that the workshop helped crystalize the issues and focus the search for effective solutions. A good example of the catalytic role the workshop played was the subsequent involvement of

Lee Bolman in the development and implementation of the CLR program. Many other examples of effective problem-solving stemming from that original workshop abound and are in evidence at this workshop.

Other similar activites followed the June, 1979 workshop, including a LOFT workshop in 1981 and a NASA/Regional Airline Association workshop in 1983. Many individual airlines sponsored seminars on the topic, and there were many symposia and paper sessions presented at such meetings as the successful Aviation Psychology symposia organized by Dick Jensen at Ohio State University. You'll be hearing about some of these later in this workshop. I think the important point to be remembered is that there is already an extensive repertory of ideas and techniques for you to draw upon during the course of your deliberations. Many of the people who have made original contributions to this area are here, waiting to make new contributions and hoping to stimulate each of you to devise still more original, effective approaches to the solution of cockpit resource management problems.

COCKPIT RESOURCE MANAGEMENT: SOME DEFINITIONS AND PRINCIPLES

Let me now turn to some substantive issues, including a definition of cockpit resource management. This will, I hope, help to structure your approach to the objectives of this workshop when you break into working groups tomorrow. However, I don't want you to think that this is the only possible definition. It just happens to be my favorite: "Cockpit resource management is the effective utilization of all available resources--hardware, software, and liveware--to achieve safe, efficient flight operations."

Several important implications follow from this definition. First, note that "resources" refers broadly to all available resources: hardware, such as autopilots, autothrottles, and other advanced avionics; software, such as aircraft operating manuals, operations bulletins, charts, and other "information"; and liveware, which refers to other accessible people in the system. Resource management, then, is the process of integrating all of these resources so as to achieve safe and expeditious flight.

Another implication of this definition is that cockpit resource management is not strictly the domain of the captain. All crewmembers (or anyone else in the system, for that matter) have resources available to them, and all have resource management responsibilities. Because of the unique role of the captain in providing leadership and command functions, he has more of the burden for effective personnel management than the other crewmembers. However, effective interpersonal skills are required of all people in the system. I think it is important to mention this here because I sense a tendency to think of cockpit resource management training as being captains' training. This is clearly not the case, and cockpit resource management skills must be taught to all crewmembers.

Let me briefly mention here some of the major dimensions of cockpit resource management which evolved out of some ideas in my opening paper at the 1979 workshop. American Airlines actually first presented these as principles, and although there have been major developments in the area since they were first mentioned, I think

they are still useful because they encompass nearly all cockpit resource management functions.

Delegation of Tasks and Assignment of Responsibilities

Workload distribution and management is an essential element of CRM. To be an effective cockpit manager, the captain must be aware of the demands being placed upon himself and his fellow crewmembers, and must take active steps to prevent task saturation by reallocating workload in dynamic situations. This is especially important in abnormal and emergency situations, and is an important part of "minding the store."

Establishment of Priorities

At any given time, pilots are faced with simultaneous, multiple, and conflicting demands for their attention. Because people are not effective "parallel processors"--a computer science term--it is essentially necessary to process these demands serially, one at a time. To accomplish this successfully, it is constantly necessary to assess the relative priorities of the competing demands, and to logically order them in order of priority. To give a concrete example from aviation: ASRS data demonstrate vividly the folly of one pilot trying to make a public address announcement while simultaneously climbing or descending to a new altitude. The number of "altitude busts" involving this combination of events is very large. All crewmembers must at all times be aware of the relative priorities of tasks and events, and must always be ready to defer completion of one task until those with higher priority are accomplished.

Monitoring and Cross-checking

This element of cockpit resource management includes monitoring and cross-checking other people in the system--fellow crewmembers, dispatchers, fuelers, maintenance personnel, ATC controllers, and everyone else. The constant evaluation of information through cross-checking independent sources is a critical component of effective cockpit resource management, and is especially important in the new advanced technology aircraft which require considerable pushbutton and keyboard programming tasks which are prone to "finger errors."

Use of Information

It is easy to succumb to complacency and fail to always make effective use of all available information to conduct any given operation. My favorite example of the consequences of ignoring this element of CRM is the "wrong airport" approach or landing. Typically these occur on a clear VFR night on familiar routes, and are always quite surprising (not to mention embarrassing and sometimes dangerous) to the flight crew who commit them. The simple expedient of tuning up all the appropriate navigation aids for the approach and using them to monitor and cross-check a visual approach would eliminate the necessity of explaining to the passengers, as one enterprising pilot did, that: "We have landed on an area of the airport where the taxiways to the terminal are blocked, and we're going to have to take off again for a short flight to another runway." This actually happened, and the pilot almost got away with it, except that a bit of automation, ACARS (Automatic Communication and

Reporting System), tripped him up by duly reporting the new "off" and "on" times to dispatch. More effective use of readily available information would have avoided the entire incident.

Problem Assessment and the Avoidance of Preoccupation

Another way of describing this dimension of cockpit resource management is "distraction management." I talked earlier about the two classic accidents (the Everglades, and Midway) which happened because the flight crews involved became distracted, by and preoccupied with, minor problems. Judging from the number of reports in the ASRS data base which describe incidents of this kind, it is apparent that it is much too easy to fall into that trap. Effective management of distraction also involves several of the other principles mentioned above, especially task delegation and priority assessment. One goal of any effective CRM training program must be to make flight crewmembers aware of techniques and practices for avoiding these problems.

Communications

To a large extent, effective cockpit resource management is dependent upon effective communications within the cockpit and with outside resources. The development of good communication skills should be the cornerstone of any cockpit resource managment training program, and the success of any such program will largely be determined by how successful it is in effecting good communications. Clay Foushee and his colleagues have done some excellent research which demonstrates the central importance of this element of CRM; for example, error rates in the Ruffell Smith experiment were directly related to various measures of communications effectiveness.

Leadership

The assurance of sound leadership by the pilot in command is one of the most difficult to achieve objectives of cockpit resource management training programs, and the effects of leadership--good or poor--are pervasive and far-reaching. The ability of the pilot in command to establish an atmosphere where he or she is clearly in command, but which encourages participation and critique by subordinate crewmembers, is critical to effective leadership. However, I want to point out that the other side of the leadership coin is followership. Training people to be effective followers is just as important as training them to be effective leaders, and should be given equal treatment in CRM training programs. Successful development of these leadership and followership skills will do much to resolve the long-standing dilemma of when and how should a copilot or flight engineer "take over" to prevent imminent disaster. Perhaps the most vivid example is Air Florida.

CRM PROGRAMS: A STATUS REPORT

In the time remaining, I want to touch briefly on the status of cockpit resource management training programs including a brief review of major NTSB recommendations regarding this issue. I know most of you are aware of the United

Airlines CLR program, and many of you have had an opportunity to observe and/or participate in some of the United courses. I think it is fair to say that the United program is a comprehensive, direct approach to solving many of the problems mentioned above. I understand that many carriers, including several represented here today, have adopted the United program, and you will be hearing more about CLR later.

The United program is one of several implemented in the past several years. USAir and Piedmont also have developed cockpit resource management training, as have Pennsylvania and Ransome airlines. Bob Mudge's Cockpit Management Resources efforts are well-known to many of you, and, of course, many airlines are using LOFT which is an effective simulator training technique for teaching CRM skills. During the rest of today and part of tomorrow, we'll be hearing other approaches and ideas, and will be applying this information to the development of still other ways of addressing these problems.

During the course of investigating many accidents, NTSB has frequently observed problems related to cockpit resource management, and has issued numerous recommendations to the FAA and airlines urging the review and development of cockpit management policies, practices and standards. A CV-580 accident in December, 1968 resulted in the issuance of several recommendations, including one to renew emphasis on, and improve wherever possible, cockpit procedures, crew discipline, and flight management. Another urged a review of practices and training for improving crew efficiency and reducing distractions and nonessential crew functions during the approach and landing phase. This was one of the earliest examples we could find, but has been followed by nearly 20 more recommendations on the same or closely-related topics.

The first direct reference to cockpit resource management in an NTSB recommendation occurred in June, 1979 when the Board issued Recommendation A-79-047 as a result of the United DC-8 accident at Portland. This recommendation suggested that the FAA urge all aircarriers to indoctrinate their crewmembers in the principles of flight deck resource management, "with particular emphasis on the merits of participative management for captains and assertiveness training for other cockpit crewmembers."

The most recent NTSB recommendation on the topic was issued in March and stemmed from the Galaxy Electra accident at Reno. In its report, the Board reiterated a recommendation made in 1985 (A-85-27) to conduct research and apply the findings thereof to pilot training programs, and issued A-86-19 to: "Provide, to all operators, guidance on topics and training in cockpit resource management so that operators can provide such training to their flightcrew members until such time as the FAA's formal study of the topic is complete." I might add that it is a pleasure to be able to work with Barry Strauch and others at the Board in promoting the continued development of CRM concepts, and pledge that we will continue to do whatever we can to hasten the implemention of these concepts.

WORKSHOP ORGANIZATION AND OBJECTIVES

With that, I would like to turn to a brief review of the organization and objectives of this workshop. The preceding discussion has, I hope, provided you with some background on the development of CRM, and has outlined some of the major dimensions of the concept. In the presentations which follow, you'll hear much more detailed discussions of many approaches taken to training cockpit resource management skills by the people who have shaped and refined the concept. All of this is intended to provide you a starting place for your deliberations during the remainder of the workshop.

Clay and his colleagues have identified four objectives for this workshop: 1) Define the essential elements of an optimal CRM training program; 2) Identify the strengths and weaknesses of current approaches; 3) Identify the best ways of implementing CRM training; and 4) Suggest ways to measure the effectiveness of CRM training. To do this, four topic areas--curriculum development, training techniques, recurrent requirements for CRM training, and CRM training effectiveness--will be addressed by eight working groups, two per topic area. Each working group will be generating a written report outlining its findings and conclusions, and these written reports will be used in the preparation of the proceedings which will constitute the final report of the workshop.

If past experience in this area is repeated, I expect the next couple of days will be highly productive and rewarding, and will result in a major contribution to the advancement of aircrew training techniques and practices. I look forward to working with you, and will try to be of whatever assistance I can. But you are the ones who will generate the real product of this workshop by making an old, but good, idea even better, and I look forward to seeing the results. Thank you very much.

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THEORY UNDERLYING CRM TRAINING: PSYCHOLOGICAL ISSUES IN FLIGHT CREW PERFORMANCE AND CREW COORDINATION

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INTRODUCTION

I had the pleasure of attending and speaking at the first NASA workshop on flightdeck resource management and have been involved in research related to the area from that time (Helmreich, 1979). As the program for this second workshop so clearly attests, a great deal has happened since 1979. What were then exciting ideas are now exciting programs. This enthusiastic endorsement of a concept is particularly meaningful to those of us who are psychologists because the issues in resource management and crew performance are core topics for social, personality, and organizational psychologists.

In this session, we will try to summarize what psychological theory and research can tell us about training in cockpit resource management. In doing this, we hope to provide a framework for the critical analysis of current approaches to CRM training. I will begin by reviewing background factors and definitions critical to evaluating CRM. This will be followed by a discussion of issues directly related to CRM training effectiveness. Finally, I will conclude by describing some of the things we *don't* know about optimizing crew performance and the research that is essential to making our efforts as effective as possible.

DEFINITIONS AND BACKGROUND

I have already used the terms "resource management" and "crew performance" and would like to make a distinction between them. I use the term performance to refer to a global concept, the total effectiveness of an individual or crew in achieving the goals of safe and efficient flight operations. Superior performance, both at the individual and crew level has two distinct components; first, technical proficiency and competence and second, resource management or crew coordination. I feel that crew coordination is the cornerstone of resource management, by which I mean the effective coordination and utilization of all available resources in the service of the flight. These resources are both inside and outside the aircraft and are both material and human, including especially the knowledge, judgment and decision-making skills of all crewmembers and the ability of the crew to bring them together in optimal fashion. While this workshop is focused on the second, resource management, and we may tend to accept technical competence as a given, we must never lose sight of the fact that the technical component is critical to overall performance.

In the research my colleagues and I have been conducting on flightcrew performance, we have attempted to assess both technical performance and crew coordination using trained Check Airmen as evaluators. There are several important facts about the performance data obtained. The first is that the Check Airmen we have worked with display a high level of agreement or reliability not only in their assessment of technical proficiency, which is to be expected, but also in the evaluation of resource management during both line checks and LOFT. This is especially interesting because the majority of Check Airmen with whom I have worked during the research have initially expressed considerable uneasiness with the idea of evaluating crew coordination. While completely comfortable with assessing technical performance, they tend to feel less adequate in this domain. The data clearly demonstrate that the majority have this ability. An important implication of this is that we can be confident in the validity of such assessments. This suggests that the formal assessment of crew coordination as part of proficiency evaluations is feasible. Consideration of the pros and cons of requiring such assessment in the future is an important task for the workshop.

The second important characteristic of the performance data is that although the two dimensions of performance are positively correlated, they still show substantial independence. This means that a pilot high in technical ability may or may not display effective crew coordination as a separate and distinct component of flightdeck performance. The research related to crew performance is summarized in a series of papers (Chidester, 1986; Helmreich, 1982; Helmreich, Foushee, Benson, & Russini, in press).

It is also essential to our training task that we specify the characteristics of individual pilots that are related to overall performance. We can identify three broad categories of characteristics. The first is individual technical ability or aptitude; the second, personality, the enduring characteristics and motivation of the individual; and the third, attitudes about personal capabilities and the proper management of the flightdeck.

ABILITY-PERFORMANCE RELATIONSHIPS

As we have noted, technical competence is a cornerstone of effective pilot performance. In addition to the obvious links among ability, training, and technical performance, there may be indirect effects on resource management. For example, a less technically-able Captain may be highly defensive and may try to preserve a self-image of competence through the maintenance of unrealistic, self-deceptive attitudes about personal competence and resistance to stress and the lack of need for support and coordination among crewmembers. This Captain may try to project an air of all-knowing confidence and independence when, in fact, the opposite is true. Such behavior may have a highly adverse effect on crew coordination.

PERSONALITY-PERFORMANCE RELATIONSHIPS

The role of personality traits as determinants of flight crew performance needs a thorough re-examination. Although personality factors were implicated as determinants of flying performance during the massive World War II research program on pilot selection conducted by Army Air Force psychologists, subsequent research has often shown inconsistent or weak relationships, leading many researchers and operational managers to discount the utility of personality factors in pilot selection and performance (Griffin & Mosko, 1977; Melton, 1947). However, a recent study conducted by our research group suggests a possible resolution of this dilemma (Helmreich, Sawin, & Carsud, in press). In a study of job performance beginning with training and continuing through months of daily performance, it was found that personality factors *did not* predict performance in training but became increasingly good predictors of actual task enactment. The results were interpreted in terms of a "honeymoon effect"--the tendency of all individuals to try hard during the excitement of training for a new position. Over time, however, as the novelty wears off and the job becomes more routinized, underlying personality traits begin to influence the quality of performance. The facade of cooperativeness and eagerness to learn of the pilot trainee may crumble during line operations, revealing a hostile, arrogant, interpersonally insensitive individual who cannot work effectively with fellow crewmen. Having surmounted the selection and qualification hurdles, motivation to hide the "true personality" is likely to fade.

The honeymoon effect may be particularly salient for investigations of personality-performance relationships in pilots since the research in both the military and civilian sectors has almost exclusively employed performance during training or the simple completion of *training* as the criterion against which personality was judged. In other words, there may have been a continuing tradition of testing for personality effects in the setting where they are least likely to be found. In research that has used ongoing line performance as the criterion, consistent personality effects are much more evident (Helmreich, 1982; Chidester, 1986). For example, among other things, a combination of high measured achievement (a desire to work hard and master new and challenging tasks) and a high level of sensitivity to the reactions and concerns of others was associated with superior line performance. In summary, personality may play a much larger role as a determinant of flightdeck behavior than we have realized.

ATTITUDE-PERFORMANCE RELATIONSHIPS

During early NASA investigations of cockpit resource management, a set of crewmember attitudes relevant to flightdeck behavior and crew interaction was isolated (Cooper, White, & Lauber, 1979). Building on this work, I developed a questionnaire measure of performance-related attitudes, covering such areas as Captain and crew responsibilities and roles, crew interaction, and reactions to stressful events (Helmreich, 1984). Subsequently, these attitudes have been found to be significant predictors of crew coordination in *line* operations (Helmreich, et. al., in press). We now have attitude measurement on more than two thousand pilots from five airlines and the Military Airlift Command. A consistent finding is that the attitudes of Captains, First Officers,

and Flight Engineers differ significantly on a number of issues regarding the appropriate management of the flightdeck (Edwards, 1986; Helmreich, Wilhelm, & Siem, 1985). Disagreement among crewmembers about how the flight deck should be run suggests that less than optimal crew coordination may be found and that achieving consensus regarding management would be a highly desirable training goal.

PSYCHOLOGICAL ASPECTS OF CRM/LOFT TRAINING

The preceding point marks a logical transition to a discussion of what psychology can say about the potential of CRM/LOFT training. A good starting point is to define the capabilities and limitations of training programs as means to effect the modification of behavior. As we noted earlier, three individual characteristics are major determinants of pilot performance: ability, personality, attitudes. Obviously, training cannot provide an individual with raw ability that he does not possess. It can, as we will discuss, help the individual better utilize his abilities and improve his skills.

A true limitation on the potential impact of training lies in the area of personality. No training program other than intensive psychotherapy will effect substantial change in personality. Thus to the extent that resource management and performance are determined by personality, this is an area where we cannot expect results. The pilot with a hostile, aggressive personality or a withdrawn, defensive personality will continue to bring those characteristics to the flightdeck.

The fact that we cannot change personality or ability represents a limit on training but by no means implies that training cannot effect dramatic change in resource management. It is in the third area, attitudes, that we can achieve substantial change in observable behavior. We are also fortunate in that there is a large research base regarding attitude formation and change on which we can draw. The data on pilot attitudes clearly suggest areas where training can be beneficial and it is reassuring to note that most of these are addressed by the programs with which I am familiar. These include decision making, interpersonal communication, leadership and leader responsibilities, and personal characteristics and reactions. For example, with regard to personal reactions, a high percentage of pilots report that their decision making capabilities are unimpaired by high stress or fatigue--something that is patently untrue. Changing attitudes about personal limitations may well result in much more adaptive behavioral strategies and coordinated behavior in critical situations where maximum effectiveness is a life or death issue.

Research in the attitude area also provides useful information on the likelihood of change and optimal strategies for effecting and maintaining change. While attitudes can certainly be changed, they also have considerable inertia and resistance to modification. (This is a good characteristic; if attitudes were highly malleable, we would be vulnerable to every commercial, advertisement or pitchman we encounter!). Attitude change also has much in common with the phenomenon of religious conversion. The new believer is vocal and enthusiastic about his/her experience, but backsliding is an all too common phenomenon. From these characteristics of attitude change, we can extract several guidelines.

First, the training effort must be credible, powerful, and active. Recipients must believe that the program is meaningful and likely to produce personally useful results. Some early attempts at resource management training were dismissed by line pilots as "charm school"--attempts to change personality and create harmony. We are not talking about getting everyone together and "holding hands in hot tubs." Participants with such attitudes tended to discount the whole process. Overall, I think the outstanding work by NASA and the NTSB has made the concept visible and credible in the industry, making the training task much easier. Nonetheless, there is still an army of doubting Thomases who must be convinced and a group who may never be convinced, given their personalities and defenses. With regard to power and activity, the trainee needs to be personally involved and actively participating in the process. The classic lecture/text instructional format does not provide the involvement and personal learning necessary to effect real change. In this context, LOFT with videotape feedback is one of the most powerful tools we have. I am convinced that CRM training without the chance for practice and self-observation that comes with LOFT will be relatively ineffective. There is also a danger that LOFT scenarios will become widely known and communicated, leading participants to pre-program. I would recommend serious consideration of this threat during our working group sessions.

Second, the Instructor/Facilitator/Trainer role is critical. The concepts involved and complexities of human behavior are formidable. The well-trained, sensitive instructor can make an enormous difference in impact and outcome. We need to devote considerable attention to the selection and training of program personnel. This also implies that we develop strategies to monitor and evaluate the effectiveness of the trainers we choose.

Third, CRM training must be continuously reinforced and omnipresent. For the religious convert, life in a world of sin and temptation without constant reinforcement leads to backsliding. Similarly, flying in an organizational climate that devalues resource management and does not reinforce its goals and practices will lead to the decay of the training impact and business as usual. This implies that one-shot CRM training, even with a powerful LOFT will not produce enduring change. It is also likely that providing the training for only one crew position, for example, Captains, will greatly degrade program effectiveness. It is critical that the concept be endorsed wholeheartedly by management, pilots' organizations, and opinion leaders in the pilot force to provide a climate in which the practice will flourish. It is also essential that CRM training be an integral part of the total training and checking process including initial, transition and upgrade as well as recurrent. Line Check Airmen can also play a crucial role by providing feedback and guidance in resource management during daily line operations--which is where it really takes place. This suggests that the Check Airmen force should become an integral part of the CRM training process, perhaps with special attention to selection and training.

In summary, from a psychologist's viewpoint, I am extremely enthusiastic about the potential of CRM training as a means of effecting real change in the bottom line of safe and efficient operations. The goals are attainable and we have the technology to reach them. Having just said that, I must make two qualifications. The first is that there are limitations on what the training can accomplish, as noted in the case of personality. The second is that there are serious gaps in the knowledge base necessary to make the

training as effective as possible and I would like to close be mentioning some of these.

While we have enormous resources in terms of knowledge and skill in training, we are trying to effect change in complex behavior where there is often no single best procedure. As Professor Hackman will stress in his discussion, we know much less about evaluating the performance of *groups* than we do about individuals. Let me simply list a few questions that need answers so that we can make the training most potent. How much change do we produce in day-to-day resource management on the flight deck? How enduring is the change produced? Do individuals revert to old, maladaptive habits under conditions of high stress? Who are the individuals for whom the training is ineffective? (If we can isolate these individuals, we could explore special training strategies. Perhaps even more importantly, we should be able to make considerable improvements in the pilot selection process.) How do we select and train the most effective trainers? What topic areas produce the most marked change in behavior? What training techniques are most effective?

The preceding list is by no means exhaustive, but as you can see it implies a very substantial research endeavor with a high potential payoff. It would be extremely helpful if at least partial answers were available *before* specific requirements for this type of training become part of the Federal Aviation Regulations. After drafting these remarks, I was particularly pleased to read the National Transportation Safety Board Aircraft Accident Report (NTSB/AAR-86/01) covering the Galaxy Electra crash at Reno. The report presents a sophisticated analysis of the crew coordination difficulties developing from a mechanical abnormality on take-off and reiterates a call for research on the most effective means to train all flightcrew members in cockpit resource management. It further recommends that guidance on topics and training in CRM be provided until research data suggest optimal regulatory action. This report provides us with a good framework for deliberation while emphasizing the need for definitive research.

There are several points I would like to make concerning the needed research and the evaluation of the effectiveness of CRM/LOFT. I have already noted that personality factors of crewmembers may provide some limits on what can be accomplished. Second, the climate and constraints in the organization and environment where the training takes place will heavily determine the impact the training has. The bottom line is that it may be extremely difficult to document the true effects of these programs in the short run. Does this mean that the research is not needed or important? Absolutely not! In fact, knowing in advance that there are undoubtedly limitations on training efficacy makes it even more critical that we establish baseline data on the resource management practiced *now* and let the data inform us how to increase our effects on all fronts. The necessary research cannot be conducted in the quiet splendor of the laboratory. It will have to be accomplished in the complex arena of daily flight operations and will have to consider the effects of training in the total context of the organization and the regulatory environment. Conducting meaningful research on these questions necessarily raises issues of great sensitivity regarding the protection of individuals and organizations along with concerns for maintaining the highest level of safety. To be valid, detailed data must be collected on all aspects of flight operation and related to training practices. This means, of course, looking at defects and instances of sub-standard performance in a non-punitive way to make sure the data reflect the true state of the system. NASA's

Aviation Safety Reporting System is an example of such an approach to data collection, but it is not typical of the way organizations keep data on flight operations and proficiency. Good research can be done if those who need the results most critically, including line pilots, managers, and regulators, cooperate to develop a comprehensive and competent strategy.

The questions before us are many and complex, but looking at progress since the 1979 convocation in this room, I am confident that the collective efforts of this group will produce a comparable effect.

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GROUP-LEVEL ISSUES IN THE DESIGN AND TRAINING OF COCKPIT CREWS[1]

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One way that Cockpit Resource Management (CRM) training can foster crew effectiveness is by building the knowledge and skill of *individual* crew members. This application of CRM training has just been discussed most informatively by Robert Helmreich, and there is much value in such training. Yet, as Bob notes, the overall task of successfully completing a flying mission is always a *team* task. Even though only one person is manipulating the flight controls at any moment, others may be simultaneously operating radios, making fuel calculations, and performing the multitude of other duties involved in flying a large and complex aircraft. Moreover, cockpit crews always operate in an *organizational context,* and the transactions between the crew and representatives of that context (e.g., organizational managers, air traffic controllers) are consequential for any crew's performance.

For a complete understanding of crew performance, then, we must look beyond our traditional focus on individual pilots to see how team- and organization-level factors can enhance (or impede) the ability of even well-trained individuals to work together effectively. This way of thinking about cockpit crews (that is, viewing them as teams that operate in organizations) offers some potentially useful avenues for thinking about next steps in the development of CRM training programs. I will explore those possibilities today, emphasizing how they can enrich (not replace) individually-focussed CRM training.

COCKPIT CREWS AS TEAMS

We often think of flying, even in multi-engine aircraft with multi-person crews, in individualistic terms. This is understandable, given that the selection, training, and assessment of pilots all focus squarely on the individual. No pilot forgets his or her first *solo* flight, when one experiences for the first time what it is like to have a flight depend wholly on one's own capabilities. The individualistic orientation of flight training is reinforced continuously throughout a professional pilot's career, both formally (in individual training and proficiency checks) and informally (through a culture that accords the highest respect to great individual pilots).[2]

Viewed in this light, the work of a cockpit crew is akin to the performance of a

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[2] For further discussion of the historical roots, current manifestations, and possible implications of this individualistic orientation, see Hackman and Helmreich (1987).

ballet: while the ballet is an ensemble performance, each member of the company has his or her own part to play, and those parts are carefully choreographed beforehand. Consider, for example, a Category II approach (as practiced by most commercial airlines): each crew member has individual duties to perform at specified times, and when all members play their parts well, the approach unfolds beautifully. While improvisation may be required under unusual circumstances, all that normally is required is for each crew member to execute his or her own responsibilities precisely in accord with the script.

Flying an aircraft is, of course, much more complicated and interesting than the above paragraph suggests, particularly when things happen that were not anticipated by those who wrote the manuals. But pilots rarely use the language of groups or teams in talking about flying. Let me illustrate with a story about an approach that did not go well. I'd like you to listen carefully to two versions of this story. The first version is as the events were related to me by a pilot (although I have altered some details). The second version is a different way of telling the same story. See what differences you notice between the two. Here is the first version:

> "...so there was this flock of geese having a tea party right over the end of 22 Left, and the tower switched them to 31 just when Charlie was getting lined up on the ILS. Well, the weather was a mess, they were vectoring old Charlie all over the place, and he got confused and got behind. Three times Phil had to remind him about something, and eventually Phil just took the airplane and landed the damn thing himself."

And here is the second version:

> "...so after they got ATIS they just assumed it would be a routine ILS approach to 22 Left and they started chewing the fat. They didn't hear the talk on the radio about the geese over the runway, so when the tower switched runways at the last minute it was scramble time. Charlie was flying, and he had his hands full because of weather and the new vectors he was getting. Phil started changing the radios to set up for the new approach, but didn't tell Charlie what he was doing--and Charlie couldn't figure out what the hell was going on. Nobody really got things organized, everybody got confused, and eventually Phil got so frustrated that he took the airplane and landed the damn thing himself."

Do you see the difference? In the first version, the one most likely to be heard, Charlie has a problem--he let a situation that was not all *that* demanding get the better of him, and he had to be bailed out by Phil, his Captain. The attributions made are all to individuals. The second account invites a group-level interpretation: the *crew* got itself into trouble, by not paying attention to changing situational demands, by not planning and organizing the work (either contingently beforehand, in real time when other exchanges on the radio suggested complications, or after the runway change was announced), and by poor between-member communication and coordination. Indeed, if someone is to be blamed in this situation, it might most appropriately be the Captain for not managing his cockpit well--an interpretation unlikely to be made based on the first account, in which Phil is implicitly viewed as the savior.

One does not often hear stories about pilots and flying that view the crew as a whole as the performing unit. Indeed, because most of us are so accustomed to talking about the performance of individual pilots, it would take a change of mindset to tell a story in which a team is the central character. Yet on occasion it may be useful to think this way. I invite you to join me in doing so now, as we attempt to identify some new ways that CRM training can be used to foster cockpit crew effectiveness.[3]

CREW EFFECTIVENESS

The first issue we must address has to do with the criterion, what we mean by an "effective" cockpit crew. Statements of criteria always have, at their root, statements of values--that is, some specification (even if implicit) of what is ultimately viewed as "good" by those who choose the criteria. So let me be explicit about ours. We ask three questions about each crew we study in our NASA research, questions that make operational our values about line flying. What I have to say later about CRM training is intended to help crews behave in ways that generate positive answers to these questions.

1. Does the performance of the crew fully meet (or, better, exceed) the standards and expectations of others who have a legitimate stake in how the crew performs? The most obvious stakeholders are the clients of a flight--such as airline passengers, or customers to whom freight is being transported by a cargo flight, or analysts who will use data being collected by a reconnaissance flight. But clients are not the only legitimate stakeholders. Others include airline or unit managers, the crews of aircraft that share airspace with the flight, and representatives of the public (such as airport and FAA personnel). Each of these groups has a legitimate stake in how a crew performs, because each of their interests is affected by the crew's behavior. And because the expectations of various stakeholders often conflict with one another, it can be quite a challenge for a crew to attempt to meet them all simultaneously. An effective crew generally succeeds in doing so. A less effective crew may focus its efforts on a single set of expectations and sacrifice all others--in effect converting a multidimensional performance problem into a unidimensional one. And an ineffective crew may fail to meet any group's expectations for its performance.[4]

2. As crew members gain experience with one another over time, do they become increasingly expert in working as a team? Many crews do so: by the time they have flown their last leg together, they are operating as a well-oiled machine. Observing such crews is like watching a fine basketball team or jazz ensemble. Members are ahead of the

[3] For the theory of team performance on which the material that follows is based, see Hackman (1986).

[4] This approach requires us to think about effectiveness in line flying very differently from the way performance typically is assessed in check rides and in research on pilot performance. For one thing, demonstrated proficiency in executing an established set of procedures and maneuvers merely affirms that a pilot has the competence to execute well the technical aspects of the work; it does not address how that competence is used to achieve performance objectives. Also, simple unidimensional measures of performance (such as fuel burn, actual versus scheduled block time, or number of deviations from prescribed cockpit procedures) are not sufficient to assess overall performance in line operations--even though many such measures may be useful as components of a summary assessment. Finally, traditional check procedures focus almost exclusively on the behavior of individual pilots; here we are asking how the *crew as a whole* does in meeting others' legitimate expectations and standards.

game, anticipating one another's moves, constantly adjusting their own behaviors to help their teammates to the greatest extent possible--and usually having great fun in the process. For other crews, the first leg may be the best leg. The longer members work together, the more problems they have in doing so. Tension and conflict can even build to the point that members actively undermine one another (as when the pilot not flying observes that the pilot flying is about to make an error, and sits back and lets the error happen; or when one crew member has elaborate, deliberate difficulty understanding what another is asking or saying).

There is evidence that crews generally do become better at working together as they spend more time together (Foushee, Lauber, Baetge & Acomb, 1986), which is good news. Yet I would argue that this does not happen automatically, and I count as one component of team effectiveness the degree to which members are able to build their capabilities as a performing unit over time.

3. Does the experience of being in the crew contribute positively to the personal learning and satisfaction of each individual member? The first of my three criteria focusses on performance outcomes, and the second on the capabilities of the crew as a performing unit. The final criterion addresses the impact of the overall experience of flying with a crew on the learning and satisfaction of individual members. In an effective crew, each member comes away from the crew generally happy with the experience, and more knowledgeable or competent than he or she was when the crew initially formed. In an ineffective crew, the experience of working together may serve mainly to frustrate or upset everyone, and even to diminish the confidence that individuals have in their own competence. Even if a crew's mission is completed satisfactorily, I do not consider it effective if members depart frustrated and alienated by their experiences in the team.

In sum, I am arguing that there is no single criterion of crew effectiveness. Instead, we must examine what happens on three different (although obviously related) dimensions: one having to do with the task, one with the capability of the group as a performing unit, and one with the learning and satisfaction of individual crew members. Can cockpit resource management help crews achieve a high standing on these three dimensions? As will be seen, my answer is affirmative--but with some qualifications that depend on what the training is about, and when in the life of a crew it is expected to be used.

FOUR CRITICAL TIMES IN THE CREW LIFE CYCLE

There are certain times in the life of a crew when CRM skills can be very helpful in achieving the criteria I just discussed, and other times when such training will be less relevant. Let me explain my thinking about this by identifying four critical times in the life cycle of a crew, and then identifying the points in that cycle at which I believe resource management training can have the greatest leverage on crew effectiveness.

Pre-Arrival: The "Shell." Many features that significantly influence the life of a cockpit crew are already in place before crew members meet prior to their first leg. Arriving for work is something like walking into a room in a hotel where you have

stayed before. The room is already furnished and the familiar layout shapes your behavior to a greater extent that you realize. (For example, recall your behavior in the last hotel you visited that had a television remote control switch at bedside but no desk or worktable, and compare that to your behavior in a room where the opposite was true.) You also know ahead of time how to relate to hotel staff you encounter--the van driver who picks you up at the airport, the desk clerk, the room service waiter--even though you have not met any of these specific people before. And you have a clear understanding about the behaviors that are and are not appropriate for hotel guests. (It is perfectly acceptable, for example, to take the little container of shampoo that appears on each day of a multi-day stay, even if you have not used up the first day's supply; but it is never acceptable to walk off with one of the hotel's blankets.) You have great latitude in how you can behave in a hotel. Yet that latitude is restricted in ways you rarely think about--restricted by how the room is outfitted, certainly, but also by your own knowledge about how one is supposed to relate to hotel staff and by general norms of conduct for hotel guests that you accepted long ago. As will be seen, the same kind of phenomenon occurs in cockpits.

I call the collection of features that are already in place prior to the first meeting of the crew the cockpit "shell." The shell is the overall structure within which the crew works, and it consists of things that are accepted as givens by crew members or that they assume to be true without questioning. Among the most significant features of a shell are:

--*The basic flying task and cockpit technology.* For an airline crew, the core task (flying a set of passengers from point A to point B as safely and expeditiously as possible) and the technology (the general configuration and instrumentation of the type of aircraft flown) are taken as given by crew members, without need for personal reflection or group discussion. If behavior is affected by how the core task has been designed by the airline, or by the technology installed on the aircraft, that influence is mostly hidden from view.

--*The roles of crew members, and the general characteristics of the people who occupy those roles.* On Boeing 727s operated by a certain carrier, for example, there always will be (a) a Captain, First Officer, and Flight Engineer in the cockpit, and (b) a team of four flight attendants in the cabin, one of whom will serve as lead. The general duties associated with each role are well-known by all, and each individual is assumed to have the knowledge and skill needed to execute his or her role competently.

--*The basic norms of conduct that regulate crew member behavior.* While these norms can vary greatly from organization to organization, there typically is substantial agreement about them within a given airline or military unit. Crew members know what is expected and valued on flightdecks in their organization, and they also know what behaviors are unacceptable. Because individuals "import" their understanding of such matters to new crews they join, there is no need for basic group norms to be explicitly discussed or re-created each time a crew forms. Such norms are simply part of the common cockpit "shell" of that organization.

In sum, the cockpit shell exists even before members of any given crew first meet. Shaped over time by technology, policy, and collective experience, the shell frames the crew's work and shapes how that work unfolds. Yet its impact often goes unnoticed--precisely because it is so generally accepted as "the way things are" in a given organization.

Team Creation. When people occupy a shell, they breathe life into it and become a *team.*[5] Previously an abstraction, the shell now becomes a real working environment. The abstract task of flying a 727 from point A to point B safely and expeditiously, for example, now becomes specific: it is flying aircraft 802 (which has one autopilot inoperative) with 92 people on board from Seattle to Denver (where thunderstorms are predicted), and then going on to St. Louis and finally overnighting in Detroit. The standard crew roles (i.e., Captain, First Officer, and Flight Engineer, working with a team of four cabin crew) are now filled with real people: it is Phil and Charlie and Linda, working with Bob (who is new), Mary Sue (who is funny), Alphons (who is the lead attendant), and Willa (who doesn't say much). And the general norms of conduct that guide crew behavior in the organization (for example, that the Captain and First Officer will fly alternate legs) are tailored and applied to present circumstances: Phil is a management pilot who needs some landings, so he will take both the first and last leg; moreover, since he has not been on the line for a few weeks, he wants Charlie and Linda to be especially quick to point out anything that concerns them.

The shell becomes a team very quickly, and very early in the life of a crew. Indeed, the team creation process begins the instant crew members first see one another--when they immediately and automatically begin to size one another up. The process continues at full tilt (even if subtly) as ground preparations for the flight are completed. By the time taxi begins, members have become a full-fledged team, and a great many things have been established that will shape behavior in the crew throughout its life (for example: that the Captain is a real stickler for following company procedures; that the cabin attendants are experienced and can be counted on do to the right thing; and that this will be a crew that has lots of fun).

Task Execution. The crew now proceeds to do its work: planning, solving problems, manipulating controls, communicating endlessly (with other team members, but also with passengers, ATC, and support staff from the organization), and so on. These activities have been well-documented and well-studied, so I will not go over them again here.

Most that has been written about the execution of the flying task focusses on how the crew functions during high workload times: the critical moments that surround takeoff and landing, plus other times when things are so busy and demanding that the safety of flight requires focussed, competent team behavior.

It also is true, however, that a great deal happens during those times when nothing seems to be happening--at 35,000 feet over Kansas, or at the hotel over dinner. Such

[5] By "team," I mean a small social system in which (a) membership is clearly defined (i.e., one can readily distinguish members from nonmembers), (b) members have differentiated roles to play in pursuit of some common purpose, and (c) the team as a whole manages transactions with other individuals and groups as it goes about its work (adapted from Alderfer, 1977). A cockpit crew clearly meets these criteria.

low workload times are occasions for people to learn from one another, and for the team to evolve and mature as a performing unit. There is no guarantee, of course, that what is learned will help performance or strengthen the team; we have all seen people learn things that impede subsequent performance, and dinner outings that nearly destroy members' ability to work together the next day. The point is that things are *happening* during seemingly task-irrelevant times, and those things are worth attending to because they can powerfully shape subsequent team behavior and performance.

Team Termination. The aircraft has been shut down and the paperwork completed. The work has been performed, whether well or poorly, and individuals are preparing to go their separate ways, whether better or worse for their experience working together. The team ceases to exist.

A given crew may or may not take time to debrief on their time together, depending on organization policy, the Captain's preferences, and (perhaps most of all) how late it is and how tired crew members are. But whether or not team members reflect systematically on their collective experiences, people have learned and been changed by their experience in the team.

There is, in effect, a residue left behind each time a crew terminates--and that residue is one means by which the cockpit shell for a given organization evolves over time. "Well," the First Officer reflects while driving home, "all that stuff they were saying in training about being assertive with the Captain certainly turned out to be hogwash. Next time I'm flying with one of the old codgers he can start down as late as he damn well pleases; if he misses a restriction, too bad. But I'm not about to stick my neck out again and get it chopped off the way I did coming into DFW...." The shell has changed. It changed only a tiny bit, and in this case not in a way that would please a CRM instructor. But it has changed, and the cumulative effect of thousands of small lessons such as this can be powerful indeed in redefining the shell that will be occupied by crews in the future.

POINTS OF LEVERAGE FOR RESOURCE MANAGEMENT TRAINING

CRM training can yield benefits at all four of the times in the crew life cycle I have been discussing: prior to arrival (i.e., by affecting the cockpit shell), at the time the cockpit team first forms, during execution of the work, and when the crew terminates. I will discuss these times in order of their amenability to change through CRM training, starting with the time of team creation--which I view as having the greatest promise. Then I examine, in turn, the impact of CRM training on behaviors during task execution, on crew termination processes, and on the pre-arrival shell.

Team Creation

As part of our NASA research project, Lt. Col. Robert Ginnett of the USAF Academy has recently completed a study of team formation in a large U.S. carrier that requires Captains to brief cockpit and cabin crew members as a group before they board the aircraft (Ginnett, 1986). Ginnett found that the briefing--indeed, the very first

moments of the briefing--shaped what happened in the crew throughout much of its life history. Apparently the initial framework established by a team has great momentum over time, a finding also true for other types of task-performing groups (Gersick, 1986).

While a given Captain tended to conduct briefings in essentially the same way on different occasions and with different crews, there was considerable variation among Captains in how they managed the first moments of their crews. Ginnett found that different Captains' briefings could be neatly categorized in terms of their impact on the pre-existing shell--specifically, on crew members' imported expectations and assumptions about how crews in that airline operate.

The best Captains *creatively elaborated* the shell. That is, they accepted and affirmed the positive expectations shared by pilots in the airline about how crews should function, and then tailored those expectations to fit as well as possible with the special circumstances of this particular flight and with the Captain's own preferred leadership style. By the end of the briefing, these Captains had built a strong sense of team identity, a commitment to excellent performance, and a set of norms that encouraged all crew members to share in the leadership of the team under the Captain's overall direction. In sum, these Captains actively shaped the team that they were to lead, and did so in a way that strengthened and elaborated the positive features of the pre-existing shell.

More typical were Captains who *affirmed* the shell. These individuals ensured that members were clear about the boundaries of the team, about any special requirements in the work that was about to commence, about the roles of all members (including how the cockpit and cabin crews would coordinate their activities), and about the way the crew would manage its relations with external groups such as ATC, ramp personnel, and operations staff. But these Captains did not take initiatives to build the team beyond normal company expectations.

A third group of Captains *abdicated* responsibility for building the team. They typically would go through the motions of conducting a briefing, but seemed to do so mainly to comply with company policy. Little real work was accomplished in these sessions, and crew members usually left the briefing room with their pre-arrival expectations and assumptions augmented only by factual data such as the names of others in the crew, dispatch information, and so on. These Captains reported that they saw little value in even having a briefing, often describing the process as "going through the motions," or as "the social hour."

A fourth (and very small) group of Captains actively *undermined* the pre-existing shell. Positive features of the shell were systematically dismantled through comments like "I know they want us to do such and so, but I think we'll just overlook that..." or by blatant behavioral violations of normal expectations (such as making a joking comment about how "the First Officer will have to run the cockpit because I'm tired and am just going along for the ride").

One would predict that teams briefed by these four groups of captains would differ substantially in their ability to work well together, and that prediction was affirmed by Ginnett's on-board observations throughout the lives of the crews. It appears, then,

that the process by which a Captain creates a team is well worth attending to in CRM training. The consequences of the team creation process are significant, and they endure for a surprisingly long time. Moreover, skills in forming a team and conducting an affirmative briefing should be readily trainable; they do not require Captains to change their personalities or to exhibit behaviors that are inherently difficult to master.[6]

Task Execution

Beyond the enduring effects of the team creation process, how much impact can CRM training have on the way crew members interact as they work their way through a multi-day trip? I have two opposing responses to this question. One type of training appears to have limited impact in the short term (but may yield significant long-term benefits); a second type can have immediate constructive effects on team performance.

I am pessimistic about the short-term payoff of training that seeks to alter how crew members (particularly the Captain) behave in periods of high stress. How are crew members likely to act when hit with an engine fire, followed by numerous secondary problems? Is that a time when they will draw heavily on their CRM training? It is very unlikely. Psychological research shows that under periods of high arousal, people revert to well-learned behaviors, exhibiting whatever response is most dominant for them for the present situation (Zajonc, 1965). Training in resource management is not going to result in an immediate change of these dominant responses; they are too well-learned for that. And therefore there will be no immediate change in how crew members act under highly stressful flight conditions.

Only over the long term, when appropriate responses also become the dominant responses, will the benefits of such training be seen. Consider, for example, the behavior of Captains during emergencies in Line Oriented Flight Training (LOFT) scenarios. According to Clayton Foushee (personal communication), Captains in the early years of LOFT training tended to become autocratic in emergency situations, firing off orders and taking personal control of the aircraft if they were the pilot not flying. Now it is becoming more common for the Captain to delegate flying to the First Officer, and then go to work on the problem with the Flight Engineer (if present), soliciting the input of other crew members along the way and taking the time needed to consider various strategies for managing the problem. According to Foushee, CRM training probably has been instrumental in achieving this gradual but fundamental change in Captains' dominant responses to emergency situations.[7]

A second type of training can result in immediate improvements in crew performance during task execution. This training defers consideration of behavior under

[6] Despite the considerable potential of well-conducted briefings for promoting crew effectiveness, there is great variation in the policy of air transport organizations regarding them. At one extreme, some military units require Captains to conduct an extensive and highly structured briefing for all working members of the crew (not just the cockpit crew); crew members report two and one-half hours before scheduled departure to allow ample time for the briefing and other flight preparations. Other organizations require a briefing, but cabin crew members are not included because their schedules are not yoked to those of the cockpit crew. In still other carriers, normal practice is that no briefing is conducted--and crew members sometimes are observed introducing themselves to one another even as they are running the pre-flight checklist.

[7] Robert Helmreich (personal communication) reports that gradual changes in pilot behavior also are appearing in response to two other types of CRM programs: those that seek to change pilots' attitudes about flightdeck management, and those intended to help pilots understand how stress affects their personal capabilities.

stressful conditions, and focusses instead on what happens when things are relaxed--for example, during low workload periods in flight, or when crew members are together outside the cockpit (such as on overnights or while waiting for an aircraft to arrive). Our data show great variation in how Captains use such times. A few use them destructively, perhaps by harping on personal complaints about the organization or starting an argument with other crew members about some task-irrelevant issue. Such behavior diverts members' attention from their flying responsibilities and may even undermine the Captain's credibility as a leader. Other Captains appear not to be aware of the leadership opportunities such times offer, and essentially squander them by letting conversation and attention wander in whatever direction it happens to go.

Some Captains, however, use low workload times to "tune" the team as a performing unit. Examples that might take place in flight include:

--Taking an initiative to re-focus attention on the flying task if it has been straying, perhaps through a comment as simple as "Well, let's take a minute and see how we're doing here..."

--Fostering crew members' learning from one another, perhaps by encouraging someone who has just returned from recurrent training to comment on what new things he or she learned that the rest of the crew ought to know about, or by initiating an exchange of experiences among crew members who have different backgrounds (e.g., corporate vs. military).

--Encouraging members to project how their situation may change as the flight progresses, and to do some contingent strategy planning based on that assessment (for example, asking the Flight Engineer to find out what is happening to a line of thunderstorms that was supposed to be moving across Pennsylvania, and then engaging the crew in conversation about alternatives for managing the approach to New York based on those data).

Beyond such "tuning" interventions, a Captain can use low workload times (or out-of-cockpit times) to continue the team-building process that was begun when the crew first formed. He or she might, for example, initiate a conversation that is explicitly about cockpit leadership--helping crew members see that they all have leadership responsibilities, that everyone needs to watch for leadership functions that need to be performed and to make sure that they actually are accomplished. If successful, this intervention should increase the frequency with which crew members other than the Captain take initiatives (such as those listed above) to "tune" the crew's performance. Another example of a team-building intervention might be to use the first evening of a multi-day trip to do an informal team self-assessment, seeking members' views about how the crew is functioning and inviting their ideas for improvements.

There are, of course, many other things that a Captain can choose to do to build a team over the course of a trip. What will be appropriate depends heavily on both the situation the crew finds itself in and on the personal styles of the crew members. The point is that an effective team leader does not merely create the team and then keep hands off; instead, he or she is constantly on the alert for appropriate occasions to strengthen the team and fine-tune its performance.

Like training in how to competently create a team, training in performance tuning and team building are intended for use during relatively relaxed times in the life of a crew. For that reason alone, it may have a greater impact on behavior during line flying than training that aspires to directly change how people behave in challenging, high workload situations. Still, training in team-oriented leadership is sure to require repetition and frequent opportunities for practice, since many Captains will find the behaviors they need to exhibit unfamiliar and awkward when they first try them out.

The potential payoff of team-oriented leadership training is great. The ultimate benefit, of course, is that when the Captain really does need to have all resources focussed on a serious problem the chances are greater that they will be available and deployed. Even if the Captain slips into an ineffective style of leadership during a crisis, help may still be forthcoming from his or her colleagues--precisely because the Captain previously took the trouble to build the crew into a strong performing unit whose members share responsibility for getting critical leadership functions fulfilled (Hackman & Walton, 1986). Moreover, such training contributes directly to achieving the second and third criteria of team effectiveness I specified earlier: namely, that the team grows in competence as a performing unit over time, and that experiences in the team contribute positively to the personal learning and satisfaction of each member.

Team Termination

The termination of a cockpit crew can be an excellent time to apply resource management training. I can only speculate on this matter, because we have collected no data specifically about crew termination. Research on other types of teams, however, suggests that the end of a group provides a unique opportunity for members to explore what can be learned from their time together. Because the team has finished its work and has no future, members may be relatively comfortable reflecting on what has transpired, and more open to learning from those reflections than they would have been previously. Just as some of the most significant lessons from LOFT exercises come after the simulation is over, so can learning from line flying be harvested at the end of a crew's time together.

For debriefings to become commonplace in commercial air carriers would require a significant culture change; in all carriers I have observed, crews generally disperse as soon as possible after the flying is completed. Because regular debriefings are so contrary to usual practice in commercial aviation, it is likely that any attempt to institute them would be met with strong resistance. Yet there are flying organizations in which end-of-mission debriefings are conducted routinely--such as military units during combat operations (Robert Ginnett, personal communication). So it is at least *possible* to conduct learning-oriented debriefings after a crew's flying work is finished.

If such debriefings were to become common practice in an organization, pilots in that organization would, over time, become more and more skilled at working in teams. The "people" part of the cockpit shell would become increasingly conducive to excellent team performance, and crews would find that they are able to get off to a faster start than previously was the case--bypassing much of the trial-and-error learning that typically occurs early in the life of a crew as members are learning how to work together. Training to help Captains become skilled at leading good termination-time debriefings

might, over the long haul, be almost as valuable as teaching them how to form a new team and get it started off on the right foot.

Pre-Arrival

Sometimes CRM training is intended to directly improve the core culture of a organization, thereby immediately strengthening the cockpit shell. The theory is that people who have been trained will thereafter arrive for work with attitudes and skills that foster effective utilization of cockpit resources, and that this learning will be exhibited in how crew members interact.

I believe that aspiration is unrealistic. It is next to impossible to engineer the culture of an organization. Instead, culture emerges from the multitude of little things that affect peoples' experiences at work, as a product of how the work is designed and managed. Culture is more useful as an indicator of how things stand than as a point of intervention for change. As CRM training pervades an organization and affects what happens in crew after crew, the culture will indeed change--but slowly and incrementally, as the result of improved crew functioning, not as its cause.

Summary

So far, I have identified some times in the lives of cockpit crews when CRM skills may be particularly useful, giving special emphasis to crew formation and termination, and to low workload and out-of-cockpit times during task execution. I also have pointed to some leadership behaviors that can strengthen the team at each of those times. Throughout, I have focussed on team management skills that are high in potential impact, that are trainable, and that are likely to be used on the line once learned. Training in these skills, most of which are fairly specific, contrasts with training that would seek to change the personality or interpersonal style of pilots (which I doubt can be accomplished, and am not sure is a good idea even if it could be), or to alter the overall culture of the organization through massive changes in pilot attitudes (which I do not believe to be a feasible objective for a training program).

The kind of CRM training I have been discussing, then, is relatively specific and modest in scope. Even so it presents a major training challenge, mainly because of its emphatic focus on teams. Such training simply does not fit well with the individualistic orientation that characterizes pilot technical training, flight standards, and flight operations management in most air transport organizations--not to mention the FAA. So there would be a strong temptation, in designing and executing team-focussed CRM training, to slip back to a more familiar and culturally agreeable emphasis on the attitudes and skills of individual pilots. It will be hard to conduct training for pilots that is mainly about teams.

Yet the *occasions* for such training are readily available. LOFT technology, for example, is ideally suited to what I have been talking about, particularly when crews as whole units review videotapes of a scenario they have just flown. The potential of LOFT for team-focussed training is enormous, and so far we have barely begun to tap it. Captain upgrade and recurrent training also offer excellent opportunities for education about team functioning, and for teaching the skills needed to be a superb team leader.

The coaching done in many organizations by flight standards personnel offers additional occasions for such training.

The ultimate impact of CRM training, however, may depend as much on other features of the organization as it does on the content of training courses. In our NASA research, Bob Ginnett and I have been working to identify those organizational conditions that most powerfully foster cockpit crew effectiveness. Let me close by providing a quick overview of some of the factors that appear to be most critical in providing a supportive *organizational* context for the use of CRM skills.

ORGANIZATIONAL INFLUENCES ON COCKPIT CREW EFFECTIVENESS

Two classes of factors have emerged in our research as especially significant in creating conditions for team effectiveness: (a) the design of the cockpit shell, and (b) the supportiveness of the broader organizational context. As will be seen, both can either reinforce or seriously undermine the impact of CRM training.

Design of the Shell

Three design features that appear to be key to team performance are: (a) the design of the team task and the supporting technology, (b) the composition of the crew, and (c) core norms of conduct that are specified and enforced by organizational and regulatory authorities.

A well-designed *task* puts the crew in control of a whole and meaningful piece of work, provides the crew ample authority to execute that work, and generates regular, trustworthy feedback about how well the crew is performing (Hackman & Oldham, 1980). Within an air transport organization, those who design missions and create schedules have considerable influence on the degree to which these conditions are met. More broadly, the engineers and manufacturers who design aircraft and cockpits are stacking the deck through the technology and automated systems they provide--sometimes in ways that enrich the crew's task, other times in ways that undermine the crew's ability or motivation to manage the work (Wiener, 1985).

A well-composed *crew* first of all means that each member individually has sufficient technical skill to perform his or her part of the work competently, and enough interpersonal skill to work cooperatively with other crew members (Helmreich, 1986). Beyond those basics, the mix of crew members (in level of experience, for example, and perhaps in personality as well) should be appropriate for the work to be done, and members should be rostered together for a long enough time that they can develop into a mature, smoothly-functioning performing unit (Foushee et al., 1986). Organizational recruitment practices obviously have much to do with the degree to which these conditions are met. But the adequacy of crew composition is affected as well by scheduling policies, rostering practices, and labor agreements that specify how individuals are matched to lines of flight. Indeed, many organizational practices that superficially appear relevant only to the quality of life of individual pilots (such as bidding procedures) turn out to be highly consequential for quality of crew composition.

Finally, *norms of conduct* that foster team effectiveness are those that explicitly reinforce crew members' collective responsibility for actively managing their flight. This means that both organizational authorities (such as training and flight standards staff) and regulatory authorities (such as the FAA) must explicitly reinforce the view that crew members are responsible *as a team* for the safe conduct of a flight, and that the *team* is expected to scan its environment and update its performance strategies continuously.[8]

One could argue that the above message is exactly what is routinely communicated to flight crews by organizational and regulatory authorities. Close examination of the actual communications received by pilots, however, suggests that this is not always the case. At least in some organizations, communications from above give primary emphasis to the responsibility of individual crew members to execute their duties competently and cooperatively, under the immediate supervision of the Captain. And, in those organizations, I have heard crew members report that their main interest is in "doing my own job right and staying out of trouble," a comment that reflects an individual rather than team mindset, and a more reactive than proactive stance toward the work. I have observed few communications from organizational authorities that emphasized instead the responsibility of the team as a whole for active situation scanning and strategy planning--even though CRM training in some of those same organizations seeks to foster precisely these norms.

Supportiveness of the Organizational Context

The design features listed above, when present, should set a crew nicely on its way toward effectiveness. But if a crew is to take full advantage of a good design it also requires on-going support from the surrounding organization. Although I cannot review them in detail here (for that, see Hackman, 1986), we have found the following organizational features to be particularly helpful to task-performing teams:

--A reward system that provides positive consequences for excellent team performance, thereby countering the tendency in the flying community to assign all consequences to individuals.

--An information system that provides the data crew members need to invent and modify team performance strategies as circumstances change, so that their strategy is always appropriate to the task and situation at hand.

--A technical support system that makes available to the crew the technical expertise and consultation that are needed when problems arise that exceed members' own knowledge and skill.

--Adequate material resources (ranging from cockpit supplies to a fuel truck at the ready) so that the work will not be unnecessarily impeded by the absence of the wherewithal needed to carry it out.

[8] This perspective raises some interesting and thorny questions--for example about the appropriateness of violating an entire crew for busting an altitude, or of having assessments of individual pilots depend in part on the overall performance of crews with whom they fly.

Summary

Imagine, if you will, a beautifully designed and professionally executed CRM program that helps crew members learn and practice precisely the skills that they need to operate well as a team in a demanding flying environment. Now place that program in an organization where lines of flight are badly constructed and constantly changing at the last minute, crews are poorly composed and short-lived, norms of conduct reinforce individual order giving and taking rather than team-level planning, excellent crew performance goes wholly unrecognized, and crews often are unable to obtain information, technical assistance, or material resources when they need them to proceed with the work.

What would you predict about the impact, and indeed the longevity, of a CRM program in such circumstances? Probably all the training will do is frustrate the trainees, because it gives them some new and interesting ways of operating that they are unable to use well on the line. To complete a good CRM course in an organization that has a badly flawed cockpit shell and an unsupportive organizational context is like getting all dressed up for a dance and having the car break down halfway there. Cockpit resource management simply cannot take root and thrive unless organizational conditions also foster and support effective teamwork.

What ultimately is needed are multiple, diverse, redundant organizational conditions all pulling in the same direction--ranging from pilot selection and initial training, to the design of crews and their tasks, to the very structure of air transport organizations and the regulatory environments in which they operate. Factors such as these are the context within which CRM training takes place, and because that context is extraordinarily powerful we must be careful not to design and execute training programs without taking careful account of it. Indeed, there may be occasions when the wise course of action is to defer CRM training, and spend energy first ensuring that the cockpit shell and organizational context will support what eventually is to be taught.

CONCLUSION

Many of us are trained as engineers or scientists, and are most comfortable when we can say "do X and Y will happen." We like tightly-linked cause-effect relations. Flying reinforces this preference: it would make life both more interesting and less pleasant if one could not count on the fact that when you push the thrust levers forward additional power will follow shortly thereafter.

Social systems do not operate the way mechanical systems do. Cause-effect relations are not tightly linked in social systems, and there often are multiple and diverse ways to achieve any given outcome. For this reason, there can be no one best way to be a good Captain or crew member, nor will we ever discover the optimal way for crew members to relate to one another. Just as there are many different ways to get from New York to Chicago (an agreeable fact if you discover a line of thunderstorms crossing your planned route), there are many ways to achieve a state of team effectiveness.

What are the implications of this way of thinking for the design and management of cockpit crews? The approach we are taking in our NASA research is to identify the several conditions that together increase the likelihood that a crew will come up with a way of operating that is uniquely suited to its performance situation (including what is going on inside the cockpit as well as outside, and what may happen in the future as well as what is happening at this moment). Rather than seeking single powerful causes of team effectiveness that can be directly manipulated, we favor putting in place multiple and redundant conditions that act in concert to build constructive momentum. Among those conditions (but certainly not the only one or even the major one) are the skills of crew members in cockpit resource management.

If we do give serious attention to the impact of group and organizational factors on cockpit crew performance, then we must also begin to broaden the focus of CRM training activities. We need to determine who has responsibility for (or the opportunity to influence) those conditions that are most potent in fostering crew effectiveness, and make those people prime targets for training in resource management concepts.

Consider, for example, flight standards staff. How can they be helped to understand (and then model and teach) that it is important to attend to group relations in the cockpit as well as to individual performance, and that crew effectiveness may have as much to do with the quality of group information exchange and decision making as it does with stick and rudder flying? How about airline managers, military officers, FAA policy-makers and inspectors, and the leaders of pilots' unions? How can we help them explore the ways their decisions affect the conditions needed for crew effectiveness? How can they be encouraged to think creatively about ways they might provide better cockpit shells and more supportive organizational contexts for flight crews?

We load too much on the Captain. He or she can do many things to promote crew effectiveness, but not everything. It may be time to get serious about bringing the resource management message to others in the flying community who have the leverage to affect the kinds of conditions I have been discussing in this talk. If that is not done, continuing to promote CRM training in traditional air transport organizations may ultimately turn out to be like swimming upstream against a strong current.

A wonderful foundation for the continued development of CRM training has been built over the last five years, largely by those of you present at this conference. Perhaps it is now appropriate to step back and reflect on ways that CRM training can be broadened and increased even more in impact. Let me close by emphasizing three directions that strike me as particularly promising in this regard. One is to orient CRM training increasingly toward crew-as-a-whole performance, rather than using powerful devices such as LOFT mainly as vehicles for getting at the performance of individual crew members. A second is to highlight things that Captains (and other crew members) can do outside the cockpit to increase the chances that in-cockpit behavior will be as competent as possible during those challenging times when there is little opportunity for reflection and planning. And a third is to start bringing key actors in organizational and regulatory contexts under the CRM tent--specifically, helping those who have authority and responsibility for the design, management, and regulation of crews learn how to create performance environments that will actively support the kinds of behaviors and attitudes that are taught in CRM courses.

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COCKPIT RESOURCE MANAGEMENT: A TOOL FOR IMPROVED FLIGHT SAFETY (United Airlines CRM Training)

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The number one goal of everyone in the field of aviation has always been safety. Throughout the industry, whenever appropriations are sought or budgets are submitted, the avowed purpose of the request is to achieve greater performance or efficiency. The underlying premise, however, is that safety be enhanced. The welcome result of this process has been an ever-improving safety record.

The most dramatic breakthrough in increasing aircraft reliability was the development of the jet engine. Advanced technology and redundancy of systems have also led to improved reliability; therefore, most accidents are no longer due to a failure of the aircraft or its equipment. Another positive factor was the development of advanced flight simulators. This resulted in almost total elimination of accidents in the training environment, while at the same time, training on the more demanding emergency procedures was enhanced.

In spite of these advancements, however, the safety statistics are leveling off and today we find little improvement in accident prevention. The part of the puzzle that has escaped solution to date is how to prevent the human errors that are now a cause of most accidents. In the period from 1970 to 1980 statistics reflected that in 60% of all fatal commercial air carrier accidents the causal factor, or one of the causal factors, was poor management of the resources available to the cockpit. If all of the fatal accidents in the aviation industry (including corporate, military, and general aviation) are analyzed for that same period, we find that 80% had as a causal factor poor management of the cockpit resources. Therefore, it is not surprising that an increasing number of recommendations made by the National Transportation Safety Board address this issue. These recommendations have emphasized the need to assure better management of the resources available to the cockpit and the need for more effective communication of vital information among the crewmembers.

Recognizing the cause of an accident is one thing, but preventing a similar accident from occurring in the future can be quite difficult. In addition, indicating that poor management of the resources available to the cockpit was the cause for the accident can be, to a crewmember, another way of saying, "It was pilot error." In the past, listing the cause of an accident as "pilot error" usually meant there was a lack of acceptable performance in the area of psychomotor skills or technical training. Therefore, an indication of pilot error as the reason for an accident is a sensitive issue with pilots and

[1] The CRM Company is a joint venture of Scientific Methods, Inc. and United Airlines, Inc.

organizations.

One of the principal reasons that effective cockpit resource management is necessary is because aviation operates in an imperfect human environment. Recognizing this, many in the industry have avoided attacking the problem in the belief that it was too delicate an issue, too ambiguous, or one that might even defy solution. It is, however, too important an issue to be avoided any longer.

Any program developed to address this last piece of the aviation safety puzzle must be one that is not looked upon as being a threat to the pilot's sense of security or one that could be viewed as something to cover the legal responsibilities of the company or the government. The best chance for success is if the program is recognized as one that enhances the professionalism of any already highly professional and skilled group.

Research efforts into the problem include the work done by KLM with their KHUFAC program. Also, NASA has been extremely instrumental with their research on LOFT and the impact of external influences on crew performance. The military has been addressing the impact of human factors, and IATA, IFALPA, and others have held numerous conferences and forums on the topic of CRM since 1975.

Success, however, in any phase of aviation training, is dependent not only on the best equipment, procedures, and techniques but on proven methods and continuous training throughout an individual's career. Highly developed and integrated training programs are successful when, in times of stress, crews react as they have been trained to do and when that training becomes part of their standard operating procedure. Therefore, if improvement is to be made in the human factors area, any training given must be of high quality, accepted by the population, and repeated often enough that it becomes an accepted ingredient in the day-to-day operation.

With this background, United Airlines in 1979 embarked upon an ambitious plan to develop a fully integrated approach to the problem. After many months of investigation and study United entered into a collaborative arrangement with Scientific Methods, Inc. to create a multi-faceted and all-encompassing training program--one that would lead to improved problem solving and also create an atmosphere of openness within its cockpits that would ensure a more efficient and safe operation.

It was first agreed that there could be no "quick-fix" to the cockpit management problem and that achieving results would not simply be a matter of gathering pilots into a room and providing a stand-up lecture on the importance of open communication nor by presenting a theory of leadership behavior. There was also agreement that effective change in teamwork skills would not be realized simply by reviewing case studies of accidents and teaching tips and techniques on improved communication.

Therefore, the two central issues that were to be addressed in determining how to best implement effective resource management training were: 1) the content of what was to be learned, and 2) the learning methodology to gain the needed behavioral changes.

There is significant data that indicate a sound, theory-based approach to the cockpit management problem can pay real dividends in improved safety through better

teamwork performance. The challenge was to provide a method or system so that, based on that theory, comparative learning for what is effective and what is not could take place. Using such a methodology, crewmembers would have a hands-on opportunity to experiment with and compare different forms of resource management. Each crewmember could then develop and crystallize his thinking as to what effective teamwork in the cockpit really means.

The Grid theory utilized by Scientific Methods was chosen as the basis for providing the understanding of teamwork dynamics. Five elements were then identified as being important in a comparative system of learning cockpit management. These are inquiry, advocacy, conflict resolution, critique, and decision making. They provide a framework and a set of standards for assessing the consequences from relying on anything but the most effective behavior. This allows anticipation and vigilance to replace complacency and assumption on the flight deck.

The Cockpit Grid uses a specially prepared text written for crewmembers. This is read as part of a home study program and is "Phase 1" of the CRM training. The use of a framework for understanding teamwork dynamics also provides a common "language" for use in applying the succeeding phases of the program.

The second phase involves a structured learning process that allows crewmembers to learn, firsthand, how to use their newly-acquired intellectual knowledge for informed understanding of behavioral effectiveness. Crewmembers are able to analyze how they react to various leadership styles in the cockpit and how their own behavior can affect operational outcomes. This phase of the training is conducted in a seminar environment, allowing the crewmembers to address this new area without the burden of the detailed attention normally necessary in the operation of a cockpit.

In the seminar, learning occurs as a result of crewmembers working in a crew concept with others and learning to be effective in using the various elements listed above to achieve teamwork. Thus, one of the important concepts in the applied theory approach is that learning comes about from the structured experience contained in the training itself as opposed to listening to a trainer, psychologist, or other kind of expert lecturing from the front of a training classroom.

The issue of personality frequently arises when resource management training is discussed and the interrelationship of attitudes, behavior, and personality is frequently focused upon. Our approach has been to concentrate on those areas of human factors where we know change can occur. These areas are principally crewmember attitudes and behavior. Personality is one area which Cockpit Resource Management training does not try to impact.

Before participants attend a CRM Seminar, crewmembers fill out several scales and questionnaires which assess their attitudes about effective cockpit behavior. Even before training, crewmembers have positions on what they believe are the most effective and ineffective styles. Statistics show that the most effective style is valued by crewmembers about 75% out of what is possible at the beginning of the program, whereas at the end of the training program, this measure increases to 88% of the maximum value possible. This is a clear indication that cockpit attitudes about effective and ineffective behavior

have been strengthened and crystallized.

Another important issue involves how crews see their own actual behavior in the cockpit. This encompasses the issue of self-deception. Unless pilots and other crewmembers can be aware that they may come across to other crewmembers in a way that is less than effective, there is probably not much motivation for behavior change since the operating assumption by these crewmembers is that they are already as effective as possible.

Statistics show that on average, 84% of the participants who will undergo Cockpit Resource Management training believe that their operating style is about as effective as possible. At the end of the training, this percentage drops to less than 30%. This indicates that considerable progress has been made toward stripping away self-deception. The import of this in the areas of both attitudes and behavior is that at the end of the training, attitudes about effective cockpit behavior have been strengthened, while at the same time, a better picture is developed for how each crewmember actually operates in the cockpit itself. When all crewmembers have received the training and a stronger set of cultural standards have been put in place, then critique and feedback can be used to strengthen behavior of others and ensure that higher quality standards stay in place.

Although individual personalities may not have been changed, a stronger set of cultural standards can create a cockpit climate and environment where the "unsafe personality" will no longer be tolerated. Other crewmembers actively use the CRM elements of inquiry, advocacy, conflict resolution, critique, and decision making in order to deal with the "less than effective" behavior of another crewmember.

Another focus of this theory-based approach is centered around the concept of synergy itself. The importance of synergy for aviation safety is based on the notion that two or three or more crewmembers working together in a sound way can come up with a more effective solution to the problem at hand than one person acting alone, or three working at cross-purposes and canceling one another out.

The concept of synergy is important for crewmembers to study especially in the context of the use of effective command structure and hierarchy in the cockpit. Synergy and its achievement through effective teamwork in the cockpit enhances the captain's command and strengthens his or her control of the cockpit instead of diminishing it. The important factor here is that the captain is open to input from others and the crew itself is jointly committed to contributing to the best possible solution. This basis of crew interaction provides the maximum likelihood that the technical competencies of each crewmember as well as the resources from all sources, human and material, will be utilized.

An important element in achieving synergy is the use of critique and feedback in order to optimize teamwork and cockpit behavior. The NTSB has noted that the use of planning and effective critique prior to a B-727 departure in Denver may have been significant in preventing a serious accident when the crew encountered windshear at the point of rotation. The NTSB commented that the cockpit resource management training used to develop the critique and teamwork skills for this crew may have been instrumental in contributing to its effective problem solving.

"The Safety Board believes that United's cockpit resource management training may have played a positive role in preventing a more serious accident from occurring in Denver and that it is an endeavor that should be encouraged. The Board previously has recognized the benefits of this training when it recommended in 1979, as the result of several accident investigations, in which the breakdown in cockpit resource management was identified as a contributing factor, that the FAA:

"Urge . . . operators to ensure that their flightcrews are indoctrinated in principles of flight deck resource management, with particular emphasis on the merits of participative management for captains and assertiveness training for other cockpit crewmembers. (A-79-47)"

The self-study program and seminar make an indispensable contribution to better teamwork, but they can only be a part of the training if there is to be the hoped-for application in the flight environment. They do, however, provide a very strong foundation upon which to build for future operational effectiveness.

Having provided the opportunity for attaining an intellectual understanding of team dynamics, plus the opportunity to apply this understanding in a seminar environment, United has made Cockpit Resource Management a part of its recurrent training program for all cockpit crewmembers.

The initial part of the recurrent training provides a refresher on the theory and principles involved in good cockpit resource management.

A line-oriented flight training (LOFT) exercise is then conducted in the flight simulator where all crewmembers have an opportunity, in their own crew position and in a familiar environment, to practice the principles previously instilled. Two flights are flown by each crew and recorded on videotape. At the conclusion of the exercise, the videotape is reviewed by the crew, solely for the training value that can be achieved. This review is conducted as a peer discussion among the crewmembers with no critique from an instructor or check airman. The purpose of the discussion is to highlight the parts of the flight that were performed well and also those that perhaps could have been accomplished in a more efficient manner. In the first case, positive reinforcement takes place and, in the second, learning for application at the next opportunity. Subsequent to the review by the crew, the tape is erased and no record kept of the items reviewed on the tape. This fosters the recognition among crewmembers that the approach is one of enhancing their professional abilities. As a result, the response of the crews to the training is very positive.

Due to the success of the Cockpit Resource Management training program, United has applied the principles to other areas of the flight crewmembers' training and supervision.

CRM leadership concepts have been incorporated into the training that crewmembers receive when they upgrade from one cockpit crew position to another. In addition, these concepts have been made an integral part of both the enroute checks that are given annually and the initial operating experience subsequent to an upgrading

exercise. The broad application has given United a fully integrated approach to Cockpit Resource Management. A United crewmember may therefore expect, from the day that he or she is hired, to find that the concepts of Cockpit Resource Management are an integral part of every facet of their experience as a crewmember.

This fully integrated approach to Cockpit Resource Management provides education in theory, practice in applying the theory, an opportunity in a recurrent training environment to critique individual and crew performance and it creates an atmosphere that encourages providing feedback to ensure better practices in the future.

A key to the success of the program is the mutual respect and confidence among crewmembers that is created, which fosters an environment that is conducive to openness, candor, and constructive critique. The result is a more professional performance due to the synergy that is achieved in the cockpit.

In summary, our theory-based approach and the methodology used in developing cockpit management skills is effective because of the following features:

1) A comparative method of learning is used enabling crewmembers to study different forms of teamwork.

2) The learning comes about as a result of crewmembers learning from one another instead of from an "expert" instructor.

3) Key elements of cockpit teamwork and effective management are studied so that crewmembers can determine how these elements can improve safety and problem solving.

4) Critique among the crewmembers themselves rather than from outsiders is used as a common focusing point for crews to provide feedback to one another on how each can be a more effective crewmember.

5) The training is continuous in the sense that it becomes part of recurrent, upgrade, and other forms of crewmember training and development.

6) The training results in sound and genuine insights that come about through solid education as opposed to tutoring, coaching, or telling crewmembers how to behave more effectively.

In response to requests from others in the industry, United Airlines and Scientific Methods, Inc. have, since September, 1982, been providing this training via their joint venture, "Cockpit Resource Management." Over 1000 cockpit crewmembers have attended these seminars and the response has been universally positive. Participating organizations include domestic and international airlines, corporate operators, government regulators, and the armed forces.

In addition, given the attention that is being directed to the need for improved Cockpit Resource Management, several large air carriers, with our assistance, have instituted a resource management training program for their own flight crews. There

have also been jointly-sponsored seminars in different parts of the world to introduce this training, and branches of the armed forces in both the U. S. and Canada are engaged in the planning process to build CRM training into their training requirements. When this is added to the large number of corporations that have committed to send all their pilots through the training, it is clear that the overall aviation community recognizes the utility and need for this contribution to aviation safety.

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THE DEVELOPMENT AND IMPLEMENTATION OF COCKPIT RESOURCE MANAGEMENT IN UAL RECURRENT TRAINING

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United Airlines

LOFT for United Airlines started in 1976. At that time it was basically no more than a line-simulated training function conducted in a full-mission simulator with no attention or stress on its human factor content.

Very soon after the implementation of the LOFT program our Flight Standards Instructors began to voice concerns about certain crew behavioral situations they were observing in the flight crew's execution of cockpit duties. These duties involved emergency procedures as well as irregular and normal procedures and situations. It was evident that new information was surfacing concerning crew interaction, or its lack thereof, in the cockpit and its effect on satisfactory performance. These observations naturally raised the question of how this information translated into the safety of aircraft operations.

Interestingly, while discussing this new program soon after LOFT training was implemented at United, Capt. Gus Sommermeyer (retired Sr. Vice-President of Flight Operations) made the following comment: "You know Dave, in 1955 we recognized we had a problem in our cockpits--but we could not identify it." We now believe we have identified the problem. The identification process came with the start of LOFT training.

Very soon thereafter, Capt. Ed Carroll, then Vice-President--Flight Standards and Training, directed a serious study of the problem which had surfaced. A short time after this effort was started the unfortunate Portland DC-8 accident occurred. That accident, which had multiple human factor implications, was the catalyst which provided even more impetus to our effort to develop training that would lead to a learning experience in Cockpit Resource Management.

The basics of the program and its rationale have been shared with you previously by Ed Carroll.

At this point I think it is important to emphasize that all of the academic learning that may be accomplished or presented in any operation does not mean anything until a vehicle or training system is in place which can bring the complete process to fruition. Let me repeat--without such a vehicle to permit a flight crew to use the tools learned, it only garbages up the mind.

At the time the CRM development process was taking place at UAL, the development team was asked to prepare the program so that a request could be made to the FAA to conduct Proficiency Flight Checks only once a year. After extensive work and a great deal of program testing, this was accomplished.

Several items had to be part of the process for FAA approval. The system had to be

repetitive, the crew interactive, and the training had to be conducted under the crew concept. The foundation had to include two additional cornerstones: 1) it was necessary to have adequate human factor content, and 2) an advanced state-of-the-art simulator and appropriate electronic devices were required. In the latter case, videotaping of the flight crews during the LOFT exercise was introduced. In the initial phase of program development, it was the impression of the development team that this concept of the program would not be readily accepted by the flight crews. This was an erroneous assumption and, quite to the contrary, videotaping of their performance was well-received by our flight crew members. The use of videotape to permit an in-depth critique of crew performance regarding human factor implications has proven to be a very effective and well-received tool. The use of the videotape is a private affair. After the critique process, conducted by a well-trained instructor, the tape is erased. Much of the success of the CRM program at UAL is, without question, a result of a joint effort between ALPA and the company. There was in-depth participation by both parties.

Several requirements involving the LOFT process have emerged during the period we have been using LOFT. All are important.

First, all scenarios need to be tightly scripted. The objectives and content need to be well-defined to produce the desired learning atmosphere and results. Secondly, the content must be rigidly controlled to enhance the learning experience. These requirements permit a composite approach to the program and permits its conduct with the desired standardization. The third requirement is the formulation of a plan for updating and the continuing progress of the system. For example, the initial United 5-year plan was:

1st year: Style identification

2nd year: Communications

3rd year: Decision-making

4th year: Critique

5th year: Judgement

I will not elaborate on them at this time, but will be able to do so should anyone wish to discuss them further during the workshop.

Early in the development of the 5-year plan company hierarchy questioned the wisdom of dealing with style identification the first year. Their point was that communication is the most important area of concern. The rebuttal of the development team, and it has proven valid, was that if you understand how people are coming across to you and the style in which they do it, you can have more effective communication. It is, we believe, one of the very basic elements of the synergistic process necessary for the safe operation of aircraft. Important also is to realize how this same synergistic process, which is necessary for the safe operation of aircraft, can be effective in a multitude of situations that require maximum team effort.

The importance of instructor participation in CRM must not be overlooked. It is necessary to emphasize the very critical part the well-trained instructor plays in the CRM program. His orchestration of the entire training exercise and his employment of very perceptive observational skills are the keys to making an enriching and productive learning experience for the flight crew. He must be schooled in the seminar and pre-work process, have good equipment qualifications, understand the instructor manual, be highly trained as a LOFT administrator, have substantial training in observational skills and be able to conduct the all-important critique process.

The final point I believe that should be made at this symposium is that no matter what you are doing or are proposing to do in the area of human factors in your operations--do something. Do it soon and move with it. In time you will get what you desire and are looking for--increased safety. I have a warm and confident feeling about the recognition of CRM and its need in our industry today. It is, I think, one of the most significant things that have appeared in aviation since the advent of the jet-powered transport aircraft.

UAL Recurrent Training Outline

Day-One:

A) CRM exercise
B) Systems and operational review
C) Evacuation training (refresher)
D) Rules of LOFT

Day-Two:

A) Pre-flight for S/O or crew for 2-man aircraft.
B) Flight planning
C) LOFT (one or two segments)
D) Proficiency check maneuvers practice
E) Critique (video tape)

Day-Three--Proficiency Check:

A) Oral
B) Simulator check
C) Special training (wind shear, required items, etc.)
D) Operational review

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COCKPIT RESOURCE MANAGEMENT TRAINING AT PEOPLE EXPRESS:
An Overview and Summary

Capt. Keith D. Bruce
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Capt. Doug Jensen
People Express

INTRODUCTION

Professional pilots work in an increasingly complex environment composed of interrelated social and technical systems. They exist at the point where the often diverse interests of the aircraft manufacturers, the FAA, the operators and the consumer converge. Among others, flight safety has long been one of the pilot's primary responsibilities and until recently was assumed to be a natural and logical result of flying skill and technical knowledge. Mounting evidence, however, strongly suggests that while "flying the plane" well is an absolutely essential and critical part of the job, it is insufficient by itself to assure safety. Consistently safe and efficient flight operations clearly depend on well-coordinated team work by the entire flightcrew. The pilot is conceptually and practically involved in a process of *flight management* that requires a mix of interpersonal, managerial and technical expertise. Little doubt exists that significant improvements in flight safety and accident prevention will result when aircrews are trained in and practice effective *cockpit resource management* (CRM), and there is general agreement on the fundamental and rather broad principles set forth in any discussion of the subject. The problem still remains to: 1) precisely identify the essential elements of CRM; 2) translate those elements into practical behaviors of procedures; 3) establish clear and realistic performance standards; 4) design effective training programs; and 5) observe, measure and document positive results.

In January 1986 in a continuing effort to maintain and improve flight safety and solve some of the above problems, People Express implemented a new CRM training program. It is a continuously running program, scheduled over the next three years and includes state-of-the-art full-mission simulation (LOFT), semi-annual seminar workshops and a comprehensive academic program authored by Robert W. Mudge of Cockpit Management Resources Inc..

This paper outlines that program and to maximize its contribution to the workshop's goals, is organized to coincide with the working groups' four topic areas.

1) PROGRAM CONTENT: the essential elements of resource management training.

2) TRAINING METHODS: the strengths and weaknesses of current approaches.

3) IMPLEMENTATION: the implementation of CRM training.

4) EFFECTIVENESS: the effectiveness of training.

It is confined as much as possible to concise descriptions of the program's basic components. Brief discussions of rationale are included where needed, however no attempt is made to discuss or review popular CRM tenets or the supporting research.

HISTORICAL PERSPECTIVE

In April, 1981, with a fleet of three Boeing 737 aircraft, People Express Inc. began scheduled passenger service to three Northeast cities from its hub at Newark International Airport, New Jersey. Following five years of unprecedented growth, the organization now operates a fleet of seventy-five Boeing aircraft (22-737's, 45-727's, 8-747's) to fifty cities throughout the continental United States, Canada and Western Europe with a complement of roughly one thousand pilots. To meet the demand for command pilots created by such rapid expansion, the company successfully tapped into the large pool of highly-qualified and experienced professional pilots that were available through late 1984. The typical new-hire during that period was a thirty-five year old college graduate with four thousand hours of turbine time. Approximately seventy percent had prior military flying operations and training experience, with the bulk of the civilian experience coming from corporate and commuter operations. A large number of pilots previously worked for other major carriers and had significant experience in Part 121 operations and training. Additionally, many airmen brought advanced degrees and a wealth of civilian business experience to the company. Teamed with equally well-educated and talented Customer Service and Maintenance Managers, the well-publicized process of building People Express began. The success of that continuing process resulted largely from the hard work and spectacular achievements of these creative young professionals.

Notable among those achievements is the company's training department. All flight crew training is conducted "in house" at two facilities including a new flight simulator center in Totowa, New Jersey featuring a 737, a 747 Phase II, and two 727 simulators. With a few administrative exceptions, *all curriculum development,* as well as classroom, simulator and flight instruction, is conducted by *current and qualified line-flying crewmembers.* Consistent with a long-standing team-oriented management philosophy, high-quality technical training and support are presented in a "resource management" context, stressing the critical importance of effective communication, teamwork and crew coordination.

Beginning with classes in late 1981, Cockpit Resource Management has been an integral part of all pilot training. CRM classes conducted through 1985 were four- to eight-hour seminars scheduled during initial, transition, upgrade and recurrent ground schools. The instructors used a mix of lecture, group discussion and accident analysis to familiarize crews with basic CRM issues such as assertiveness/authority balance, communication and the whole problem of crew coordination. Once the general concepts and goals were understood, there was still a need to design and implement a program

with clear objectives that gave the pilot an opportunity to learn practical methods for positive and effective *cockpit management.*

Therefore, to further refine and broaden our understanding of CRM concepts and provide crews with relatively simple but effective cockpit management and leadership "tools," the current program was developed.

PROGRAM CONTENT

The academic portion consists of the following twelve study units:

1) About Cockpit Management
2) Attitudes and Skills
3) Communications and Briefings
4) Short Term Strategy
5) Challenge-Response Operational Environment
6) Authority-Assertiveness Balance
7) Cockpit Management Style
8) Workload
9) State of the Cockpit
10) Pilot Error
11) Judgement and Decision-Making
12) Emergencies and General Review of the Program

The first two units examine professional flying and the complex aviation environment. Cockpit Resource Management and safety are discussed and defined and some basic management functions are examined. The captain's role is defined as that of cockpit manager; the first and second officers are his backup and the primary safety monitors. These roles are addressed and refined throughout the course. Several broad issues such as the pilot's responsibilities, the nature of command and the importance of positive attitudes and an open mind in achieving positive results from CRM training are discussed. The balance of the course deals with a number of specific CRM elements. In reality these elements are interrelated parts of the flight management process mentioned earlier. However, much the same as many technical courses break a complex process such as instrument flying or the aircraft itself down into elemental parts for study, the remaining study units systematically examine these elements with three basic objectives in mind. First the pilot must simply *understand* the element and its relationship to the whole flight management process. Particularly important is his understanding of the potential for negative or positive impact on flight safety and the achievement of flight goals. Next he must be aware of and able to *recognize* both the presence and impact of the element in actual operations. Finally, he must *act* to manage the cockpit by controlling these elements, effectively using the appropriate resources and providing strong leadership such that flight goals are consistently, efficiently, and *safely* met in the context of a well-coordinated crew effort.

Specific elements covered in the course are listed below:

1) Problem Identification
2) Short-Term Strategy
3) Briefings and Communications
4) Challenge-Response Operational Environment and Monitoring
5) Management Style
6) Leader-Follower relationships
7) Management Actions
8) Authority-Assertiveness Balance
9) Judgement and Decision-Making
10) Subtle Coercion
11) Workload
12) State of the Cockpit
13) Use of Resources
14) Standard Operating Procedures
15) Pilot Errors
16) Flight Warnings
17) Irrelevant Communications

In each case, simple effective methods to improve performance are provided. For example, *short term strategy* provides a systematic way to identify problems; formulate plans; validate them with other crewmembers and modify if needed; activate the plans and then monitor and control their progress. Within the framework of that strategy, the pilot would do other specific things such as *recognizing* and *reducing* errors. That process would entail specific actions and behaviors and so it goes.

The *Management Style* unit examines in detail the issue of goal vs. team-oriented management styles. The characteristics of each style are discussed and arguments favoring a "balanced style" are presented. The hands-on project for this unit leads the pilot through a series of questions and observations to help him learn more about his style. He is asked to assess the positive and negative results of it and is given suggestions and guidelines for change and improvement.

TRAINING METHODS

The program consists of three basic parts: 1) Self-Study Academic Course; 2) Workshop Seminars; and 3) LOFT (full-mission simulation). Each part is described below.

SELF-STUDY ACADEMIC COURSE

Each study unit consists of a printed *Text* and two audio cassette *Tapes*. The *Text* uses a workbook format and contains the following parts: title page; abstract; workbook--used interactively with the lecture tape; text; self-evaluation flash cards; hands-on observation check sheet; discussion questions; study unit critique; and

supplemental reading.

The *Tapes* are: 1) A *Lecture Tape* used interactively with the workbook section of the *text*, and 2) A *Panel Discussion Tape* (several well known aviation experts discuss and debate various CRM issues).

WORKSHOP SEMINARS

Every six months, after completing two study units, the pilots meet for a one-day workshop. The following format is used. 1) Group discussions of the *Text* material, the *Discussion Questions*, and the *Hands-on* project. 2) Selected technical and CRM video tapes are viewed and discussed. 3) An NTSB accident report is studied and an analysis completed using a detailed five-part format. When certain study units are covered such as *Management Style*, selected exercises will be included in the workshop and specific self-assessment instruments administered.

LOFT

Full-mission simulation is the focal point of the entire program. Simulators and classrooms are equipped with state-of-the-art audio-visual systems. The scenarios are designed to maximize the crews' opportunities to apply and practice CRM methods and behaviors to realistic operational problems.

It is important to note here that the same line captains responsible for designing and implementing this entire program are currently training additional instructors, training the check-airmen in all three aircraft, developing additional courses for new instructors and new pilots and conducting all the classroom and simulator instructions. Continual refinement and improvement are explicit parts of the over-all program design.

IMPLEMENTATION

Each crewmember will complete two study units and a workshop every six months. Annual recurrent training already includes a half-day CRM seminar, and since January 1986, an additional eight-hour workshop is scheduled for each pilot. That additional workshop will occur five or six months opposite the individual's recurrent training month to coincide with and precede the LOFT. Captains will receive LOFT training during each PT cycle. Current plans are to schedule first and second officers for an annual LOFT ride in addition to the normally-scheduled simulator training.

At the conclusion of each workshop, Part A of the next study unit and the accompanying lecture tape are handed out. Each month thereafter for three months the balance of the study units are distributed to the individual through company channels. This cycle will repeat every six months for the three years this phase of training is scheduled.

EFFECTIVENESS

Various individuals and groups are working with the company on the difficult problem of measuring the effectiveness of CRM training. Among others, Helmreich, Hackman, Wilhelm, Foushee, Russini, Benson, and Chidester have helped establish a large personality, attitude, and performance data base for use in future measurement projects.

Several other methods are being used to determine and improve the program's effectiveness. Primary among those is the *behavioral* approach to the design of the course. The academic portion is based on the pilot learning specific behaviors. So each unit has *Specific Behavioral Objectives* (SBO's). Workshop themes reflect those SBO's and obviously the LOFT performance criteria are based on the same ones. The SBO's themselves reflect clear operational leadership/management requirements and are carefully designed to be simple, clearly identifiable, relevant and effective. For detailed discussions of the SBO design, the reader is referred to R.W. Mudge and CMR Inc.

The check airmen on all three aircraft are taking accelerated CRM courses designed specifically for supervisory pilots. Thus, as the entire program progresses, annual line checks and simulator training sessions will be increasingly conducted and debriefed in the *cockpit resource management* context.

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COCKPIT MANAGEMENT AND SBO'S

Capt. R. W. Mudge (ret.)
Cockpit Management Resources, Inc.

I have been asked by People Express to discuss the subject of SBO's as used in our cockpit management training program. I shall give you a quick overview and then ask those of you who may be interested in further detail to either talk to me directly or read through our supplemental material which is contained in the blue binders on the table in the back of the room.

The worth of any training program depends upon the amount of lasting, beneficial behavioral change that takes place within participating pilots. If no such change occurs, the program is worthless.

Since so much depends upon the amount of lasting, beneficial behavioral change that takes place within participating pilots, it seems logical that we should precisely identify the change desired. Once done, this then defines the course content and provides a fine means of measuring the effectiveness of the program.

One of the primary tools we use to accomplish this task is the *specific behavioral objective* (SBO). An SBO is simply a statement which specifically identifies a small segment of the final behavior sought, and a little more. The key work is *specific*. We pinpoint *exactly* what it is we want the pilot to *do* after completing training, and what we should evaluate from the point of view of both the program and the pilot.

It tells the junior crewmember exactly, specifically, what he should *monitor* and *support* insofar as the management function is concerned. It gives greater meaning to the term "second in command." And finally, it tells the supervisory pilot exactly what he should *observe, evaluate, and instruct,* insofar as the management function is concerned.

This means that we must specifically target our SBO's toward each flightcrew position--captain, junior crewmember and supervisor. Therefore, because each SBO represents only a very small segment of pilot behavior, we end up with a lot of SBO's.

At first we might think all we had to do to create a good cockpit manager is simply to teach him the necessary skills, as we do when we check him out in a new aircraft. But it's not that easy. A pilot will use only those skills which are consistent with his beliefs, his attitudes, his philosophy, and with his factual knowledge base.

A pilot's attitudes form a protective umbrella that permits those skills consistent with the attitude to flourish. Any skill which falls outside of this umbrella will soon perish. By the same token, the skills we use must also be supported by a strong and compatible knowledge base. Once again, any skills we are taught, which are not so supported, will also soon disappear from our normal practiced behavior.

The situation we are apt to find in the industry today, among experienced pilots, is a mish-mash of favorable, unfavorable, and missing management skills. Since we do not instruct our pilots in cockpit management methods, we find they have relatively few management methods, and some of those they have are not appropriate. One of the problems is that the protective umbrella of attitudes is not always proper, nor is the associated knowledge foundation.

Therefore, we must also work with attitudes and knowledge. We work with both in very much the same way we deal with SBO's that identify management skills. We call them attitudinal SBO's and knowledge SBO's. A true behavioral scientist might not like this, but it works for us.

We must eliminate the negative skills, and add positive ones to provide a well-balanced repertoire of skills protected by a strong attitudinal umbrella and knowledge base.

SBO's form a series of small, managable steps that lead inevitably to goal accomplishment. If we have a goal of a certain management style, we can teach behavior that is consistent with this style, and the goal will be attained.

Our SBO's are also designed to indicate the media that will be used to evaluate the behavior. We have primary SBO's which will be checked on each training and check flight. We have primary SBO's which can be observed and evaluated on the flight deck and will be checked during the LOFT or flight check associated with the study unit. Finally, we have secondary SBO's which cannot be adequately checked on the flight deck and some alternative, more academic, means must be used.

With SBO's we are able to precisely test the program to see how well he/she has learned. Each SBO is charted with respect to the course organization. Thus in testing with SBO's we are able to precisely test the program to see how well it teaches and test the pilot to see how well he/she has learned. If we find an SBO that is not being satisfactorily taught, we can easily troubleshoot the program and make modifications to improve teaching effectiveness.

From a trainer's point of view, the route to lasting, beneficial behavioral changes on the flight deck demands the development of a consistent and strong combination of attitudes, skills, and knowledge. Further details of how SBO's are used within our program are described in our hand-out material. Time simply does not permit a detailed discussion here.

As we have said, SBO's are but one tool that must be used to develop a successful cockpit management training program. We should not forget that we must build our programs on solid educational grounds. We must assure that we use sound instructional technology. It is only in this way that we shall develop truly effective programs directed at valuable goals--programs that may be effectively evaluated and efficiently repaired.

Some of the other factors we have found to be important include the following:

1) Time must be allowed for behavioral changes to take place.

2) Pilots must be given private time to *THINK* and for introspection. This is extremely important in this kind of learning, and we have found it to be the most important media used.

3) Our programs must be non-threatening to participating pilots.

4) Inasmuch as most programs of this type do impose upon the free time of the pilot, the material must be presented in convenient form.

5) Our programs must deal with real-world problems and be expressed in the pilot's language. The pilot must not be required to learn terminology of other disciplines in order to manage the flight deck.

6) The program must actively stimulate thought.

7) The program must accept the responsibility to adjust to the organization and the individual, rather than the other way around.

8) To understand our beliefs, we must put them in words. To understand them with precision, we must write them down.

As an illustration of one program's general instructional organization we present a breakdown of the instructional process used in *Cockpit Management - An Interactive Learning Experience*. This will be found following the summary.

SUMMARY

So far the pilots' reception of the program has been excellent. Their suggestions for improvement are actively solicited and incorporated whenever possible. One of its fundamental strengths is the fact that it was developed and is conducted for pilots by pilots. Almost everyone involved with the program is a highly-experienced, practicing airline pilot.

To the maximum extent possible every part addresses the practical needs of a professional pilot. By no means however, is the program in any final or perfect form. Every aspect of the industry is changing and the whole CRM subject is far from maturity on several levels. The program will therefore change to meet the pilot's changing needs, and it will definitely improve as our collective experience with the problems and issues addressed by this workshop increase.

It may be difficult to understand why this young company is willing to commit substantial resources to such an ambitious project that is neither required by the FAA nor based on any tried and proven foundation. Much of its success is clearly attributable to a fundamental business and leadership philosophy throughout the entire organization that is directly aligned with the basic tenets of Cockpit Resource Management theory.

Several of the original advocates of CRM training were recently promoted to key management positions in the organization. Needless to say, more and more of the entire enterprise's activity will proceed in a "resource management" context. It must be remembered also that those creative young professionals that started the painstaking process of building the airline back in 1981 have grown into fearless problem-solving experts who can accomplish almost anything they decide to. Finally, and probably most importantly, many of the individuals involved with this project are motivated by the desire and this rare opportunity to make a significant and lasting contribution to aviation science and the quality of air transportation.

THE INSTRUCTIONAL PROCESS

INSTRUCTIONAL GOAL: To produce lasting beneficial behavioral change based on the SBO's related to cockpit management and upon which the curriculum is based.

INSTRUCTIONAL PROCESS: This is *how* we learn and is indicated in the first column--reading, writing, listening etc.

INSTRUCTIONAL TECHNIQUE: The conceptual methodology of instruction used in the program. This is shown in the next column and includes such techniques as self-study, tutorial, group interaction, expert input and so forth.

INSTRUCTIONAL MEDIA: The means of communicating instructional information. This is indicated in the third column and shows the media selected--text, audio tape, workbook, tutorial, role play--like that.

INSTRUCTIONAL STRATEGY: The instructional plan to be used to attain instructional goals. The fourth column gives an abbreviation for the instructional strategy involved. The code is shown below:

C -- Credibility

E -- Economy

I -- Interaction

R -- Real world material dealing with problems pilots will relate to easily.

C.S. -- Case Study

CON-- Convenience for participating pilot.

IDQ -- Interactive Discussion Question

MLT-- Multiple learning technique--basic course material presented in a variety of media.

TDQ-- Team Discussion Question

RED-- Redundant (Although not used as a code, this strategy exists throughout the program and is designed, through careful timing and sequencing, to gradually flatten the forgetting curve.

The last column shows the type of SBO's. The code is as follows:

A --Attitudinal SBO's
B --Skill SBO's
K --Knowledge-based SBO's

LEARN-TEACH PROCESS	TECHNIQUES USED	MEDIA USED	STRATEGY USED	PRIME SBO's
Reading	Self-Study	TEXT	MLT,R,I,CON,E	ABK
	Tutorial	IDQ Response	MLT,R,C,I,CON	ABK
	Group Inter.	Case Study	MLT,R,C,CON,E	AB
	Expert Input	Suppl. Rdg.	MLT,C,I,CON,E	AK
	Self-Eval. Study	Flash Cards	MLT,I,R,CON,E	K
	Self-Eval.	Self-Quiz	MLT,I,R,CON,E	K
	Person Invent.	Prog. Inter.	I,CON	A
Writing	Prog. Inter.	Workbook	MLT,I,R,CON	K
	Tutorial	IDQ Response	MLT,C,I,CON	AB
Listening	Self-Study	Audio Academic	MLT,R,I,CON	ABK
	Expert Input	Audio Panel	MLT,C,I,CON	ABK
	Prog. Inter.	Audio Situat.	MLT,R,I,CON	AB
	Tutorial	IDQ Response	MLT,C,I,R	ABK
Seeing	Self-Grp. Study	Graphics	MLT,I,R	ABK
	Group Inter.	Video-LOFT	MLT,C,R	B
Doing	Practice	Hands-On	MLT,R,I,C,CON	B
	Pract.-Eval.	LOFT	MLT,R,I,C	B
Thinking	Tutorial	IDQ's	MLT,R,I,C,CON	ABK
	Group Inter.	TDQ's	MLT,R,E,G	ABK
	Group Inter.	C.S.Analysis	MLT,R,G,E	AB
	Group Inter.	Debriefs	MLT,R,CON,E	AB
	Self-Study	Self-Eval.	MLT,R,CON,E	AK
	Self-Study	Flash Cards	MLT,E,R,CON	K
Interaction	Tutorial	IDQ's	MLT,R,I,CON	ABK
	Group Inter.	TDQ's	MLT,R,G,E	ABK
	Group Inter.	Role Play	MLT,R,G,E	AB
	Group Inter.	C.S.Analysis	MLT,R,I,CON,E	AB
	Pract-Eval.	LOFT	MLT,R,G	B

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PAN AMERICAN WORLD AIRWAYS
FLIGHT TRAINING -- A NEW DIRECTION
FLIGHT OPERATIONS RESOURCE MANAGEMENT

Capt. Roy Butler
Director, B-747 Training

The Pan Am Flight Training Department would like to share with you the experiences we are having in our attempt to integrate cockpit resource management philosophies into our training programs. We will also show you a slide-tape presentation on Pan Am's new direction in flight training, but first lets look at how Pan Am got where it is today.

Pan American's commitment to flight crew training is synonymous with the date this airline commenced operating. Long before flight crew training programs and training facilities were federally mandated, Pan Am had established specific training programs for its flight personnel. Over the years this training has consistently been under review and has been modified to reflect changing standards and trends within the industry.

In the early 1970's, with the introduction of the B-747, SBO concepts were to become the cornerstone of Pan Am's training environment. Crew concept was being introduced as an integral part of the new training experience.

In 1974, a flight operations review team chaired by David D. Thomas, former Deputy Administrator FAA and then President of the Flight Safety Foundation, recommended the further development of crew concept to include more realism in the simulator proficiency check, with increased emphasis on line-oriented operations.

In 1984, ten years after the introduction of crew-concept training, Pan Am commissioned a flight operations review team to examine every aspect of flight operations, to identify problems and to provide solutions. The primary purpose for conducting this study was our concern for flight safety. No limits were placed on who the team could meet with, or on what the team could examine, observe, discuss or recommend.

The team was composed of five members from Pan Am and five members from the aviation industry, including the Honorable John K. Lauber, who at that time was Chief of the Aeronautical Human Factors Research Office at NASA-Ames Research Center.

Several recommendations were made by this group following completion of their study. One was that human factors training should be introduced to supplement a successful crew-concept training program already in place. Another was that line-oriented flight training (LOFT) offered a unique opportunity for improved training, particularly in the area of command, resource management, crew concept and problem solving, and that LOFT type training should be implemented as soon as possible. This lead to the establishment of a team within Pan Am to determine how best this training, that is training in human factors, could be accomplished.

The slide presentation that I'll show you in a moment was initially prepared by this team to convince the Flight Operations Department management that the recommended program for human factors training should be implemented and that it was a required part of the proposed annual training exemption. This presentation has been modified several times. In its present form it has been used to introduce our three-day seminar and to give the participants some background on the how and why of the new direction in training at Pan Am. We hope it will do the same for you.

[EDITORS' NOTE: The following is the script from the slide-tape presentation. It is a good example of the use of that communications media and provides the complete message, even without copies of the slides. The numbers in parentheses are the numbers of the slides.]

ANNUAL FLIGHT TRAINING

(Script)

(1) Pan Am International Flight Academy

(2) Recurrent Training: The Past, The Present, The Future

(2a) The Future: Annual Flight Training

(3) As we all know, when a passenger buys a ticket to fly with us, we automatically enter into a contract with him to provide safe passage to his destination. We hope to provide him with a pleasant trip and an on-time arrival. However, overriding these and all other factors is our dedication to safe flight. Safety is not only a contractual and moral obligation, it is a business necessity.

(4) Crew training is an important element in this commitment to safety. Crew training is expensive and becomes more so each year. Our obligation in Flight Operations is to ensure that we are spending our training dollars not only wisely but efficiently.

Most of us in this room have been involved in aviation for a lot longer than we would like to admit. We're pretty sure of what works. At least we know what has been working. When a change is suggested we are usually on the skeptical side. "If it ain't broke, don't fix it" is not far from our philosophy. This is understandable when you consider that most changes produce controversy, endless argument and the consumption of valuable time. Trainees, union representatives, instructors and others have to be convinced that the change is necessary and not just for change-sake.

(5) In training, we are approaching a juncture where we need to review our programs, examine our opportunities and chart the way for the future. Obviously any change must meet our mandate for safety of flight and for a well-trained crewmember. New technology allows this.

(6) Since our present programs were instituted, a combination of factors or circumstances have intervened to allow us to now consider change. Simulator improvements is one of these factors.

(7) Improved simulator technology provides greater computer capacity and iteration rates, better visual systems, a motion system which provides much improved motion cues and airplane control-feel dynamics that duplicates the airplanes. Furthermore, Phase II simulation will include three-dimensional windshear dynamics, stopping and directional-control forces to cover six variations in runway conditions, representative brake- and tire-failure dynamics, operational navigational systems including INS and OMEGA, sound of precipitation and significant airplane noises which are perceptible to the pilot during normal operations, an improved visual presentation such as variable cloud density and partial obscuration, four-window field of view, and lastly the capability to present ground and air hazards. The end result is a simulator that truly simulates the airplane and a training vehicle we have long awaited.

(8) Pan Am's Board of Directors approved $2.9 million to allow us to update our present simulators to these state-of-the-art standards. This program is well underway and will be completed by mid-1986. All A300 and A310 simulators will be delivered with these improvements. What do we do with these simulator improvements? Do we keep plugging on with the same old programs or do we take advantage of these technological improvements?

(9) Every indication seems to say that now is the time for change. Other factors or circumstances which support change and which have received FAA and ALPA endorsement are Flight Operations Resource Management and Line-Oriented Flight Training (LOFT) programs.

(10) Let us now spend a few moments on LOFT. Most of you are familiar with the LOFT concept, but let me briefly review it. LOFT is a total training concept which requires line airmen to occupy the same crew position, the same duties, the same responsibilities, and the same roles they have in day-to-day operations. It covers a flight from crew report-time to the blocks at destination.

(11) With that brief review of what LOFT is, let us look at some of the advantages of this type of training. First of all, LOFT is realistic training. Each training scenario is for a total flight, including all operational considerations.

LOFT permits the opportunity to encounter irregularities and operational problems in a line environment which cannot be duplicated for training purposes during a real line flight. LOFT is effective in gauging not only the crew's knowledge of the airplane and the elements in which it operates but also the judgment and cockpit resource management that is demonstrated during all phases of flight. In summary, LOFT not only covers how you fly the airplane, but how the total crew works together under Pan Am's crew concept.

(12) LOFT is always training. It is full-mission simulation. There are no interruptions--no freezing of maneuvers for discussion and analysis. The flight is a real flight, in real time, from beginning to end.

(13) LOFT provides the environment for the following cockpit resource management principles as practiced through the use of crew concept:

- o Resource management
- o Crew coordination
- o Crew communications
- o Crew management
- o Timely decision-making
- o Use of specific procedures
- o The problem-solving process

An examination of air carrier accidents, almost without exception, points to a breakdown in one of these areas as being the primary or at least a contributing cause. And these are the very problems that LOFT addresses.

(14) We in training have been following the development of LOFT for years. We have studied the various guidance material developed by the FAA, studied what other air carriers and NASA had to say about LOFT, developed various LOFT scenarios, and experimented with these scenarios in our simulators. Other airlines have already adopted some version of LOFT into their training programs. Without exception, these companies and their crewmembers report LOFT as one of the biggest advancements made in crew training. The FAA has recognized the value of LOFT and has issued various Advisory Circulars and exemptions of regulations which permit the use of LOFT in recurrent training in lieu of periods devoted to the practice of maneuvers and procedures.

(15) Now let us look at the other major item which the FAA requires as part of its new approach to recurrent training--Flight Operations Resource Management.

(16) Historically, pilot training has focused on flying skills and systems knowledge while neglecting or ignoring such factors as how pilots communicate with one another, the effective sharing of relevant information, and the process of decision-making. In recognition of this most important frontier in aviation safety, flight operations resource management has been developed to provide learning in the personal and interpersonal values and behaviors which are essential to optimum performance in the cockpit.

(17) Flight Operations Resource Management objectives include:

- o Definition of the individual crewmember's role
- o Recognition of effective communications
- o Recognition of resources available
- o Recognition that CRM is the responsibility of all crewmembers

(18) Flight Operations Resource Management produces total performance of the crew which is greater than the sum of the performances of the crewmembers taken independently. That is synergy.

(19) The FAA has recognized the importance and validity of cockpit management training by allowing recurrent training to be accomplished on an annual basis when management training is coupled with LOFT. United Airlines has been using a similar program since 1981 with excellent results.

(20) NASA studies over the last ten years indicate that well in excess of sixty percent of fatal air carrier accidents were not directly related to mechanical failure or lack of pilot skills, but were due to a breakdown in crew concept and resource management in the cockpit. These NASA studies have emphasized a deficiency in present recurrent training in that the accidents appear to occur largely in areas related to human factors in which the industry does not train, does not evaluate, does not check.

(21) This deficiency in human factors training is also true for Pan Am. A look at those accidents that occurred from 1970 through 1974 and involved either fatalities or substantial damage revealed that the cause of 73 per cent of these accidents is related to cockpit management.

(22) As a result of these accidents, Pan Am in 1975 created a flight operations review committee. It was chaired by David D. Thomas, former Deputy Administrator-FAA and the then president of the Flight Safety Foundation. One of the recommendations of this committee was that crew-concept training be introduced. The accident figures for the ten years following 1975 have decreased and the percentage of cockpit management-related accidents have dramatically decreased to fifty-six percent.

(23) To further improve flight safety we must make the crew concept more effective. A tool to accomplish this is flight operations resource management.

(24) Pan Am's Flight Training Department has made an in-depth study of how this type of training could be developed and then offered to the airmen.

(25) This Pan Am study recommended purchasing a cockpit resource management program as opposed to developing such a program in-house. The purchased program has been tailored by Pan Am and is presented as Flight Operations Resource Management training.

(26) Other flight training organizations within the aviation community are also emphasizing the use of cockpit resource management in their flight training programs.

(27) Here is what Pan Am's Flight Training Department's analysis produced after months of dissecting the training programs of other airlines and the UAL exemption which permits annual flight training. This analysis also involved evaluation of other companies which offer cockpit management training and then combined all of these considerations with those special problems and requirements of Pan Am.

(28) In order to adequately present the basic foundation to this new training program, it is necessary for each airman to participate in a three-day seminar. This seminar is a one-time requirement for each airman. Briefly here is what the seminar is all about. Flight operations resource management training is training which requires the airman, through introspection, to analyze his own management style. To achieve this introspection requires interaction on the part of the airman with other airmen. In the seminar, team-play will be actively used to produce the individual-to-individual and team-to-team interaction so vital to the germination of introspection and determination of the airman's own management style. It is not an attempt to measure personality.

(29) In the first year of annual training, each airman will be scheduled for one day of ground school which will cover emergency evacuation and emergency equipment training, security training, and airplane system training.

(30) This will then be followed by a LOFT exercise consisting of a two-and-one-half hour flight in the simulator. Following the LOFT training a self-critique will be conducted by the airmen to measure the effectiveness of the training. Following the LOFT flight, practice maneuvers will be accomplished in the simulator and the next day the proficiency check will be flown.

(31) In subsequent years, following the first year of transition to annual recurrent flight training, each year will consist of two days of ground school, one day of LOFT and one day for the proficiency check.

(32) The LOFT period permits the elimination of semi-annual recurrent training as we know it today. Annual training will not totally eliminate certain training accomplished during the present recurrent training. Procedures and some maneuvers will still be utilized, however, they will not be practiced in isolation but will be accomplished as a part of the total operation of the flight. They will occur as they would in line operation.

LOFT will also allow sufficient time for practicing maneuvers which are currently accomplished in the current training periods. It should not be overlooked however, that LOFT does enable the trainee to glean certain simulator familiarity during the conduct of the LOFT session and, in addition, certain required maneuvers may be signed-off during the LOFT and practice periods.

(33) Another advantage produced by the use of annual training relates to the proficiency check. First, both the LOFT period and the proficiency check utilize crew concept. Next, the proficiency check uses an enroute environment whenever possible.

These two factors plus improved simulation allow an airman to better demonstrate his true proficiency.

(34) Earlier in this program we mentioned the forces at work in the Industry and how these forces have produced various changes which are possible in recurrent training. We have just presented the Pan Am Flight Training Department proposal. Now lets look at the economic advantages of that proposal.

(35) The introduction of annual recurrent flight training will produce several substantial economic benefits to Pan Am. First will be a potential airmen productivity increase at each crew base. Annual training will result in a decrease in travel time for most airmen. In addition, one training day is eliminated. Therefore annual recurrent training offers a potential of an additional three days availability per airman at most base stations.

(36) All evidence indicates that now is the time to restructure Pan Am's recurrent flight training program. This is possible because of improved simulator technology, adoption of annual training, and the application of flight operations resource management concepts during line checking.

(37) Annual flight training produces a flight crewmember better trained to cope with today's operational problems and ensures the fulfillment of our number one goal--to produce the safest transportation possible for the traveling public. Today is your first step in that direction.

(End of Script)

Pan Am's unique situation in terms of demographics, the merger of two airlines and a recent recall of furloughed flight crewmembers had to be addressed. The median age of all cockpit crewmembers is fifty. Seventy percent of the airmen are between the ages of forty-six and fifty-four. In many cases, the captain, first officer, and flight engineer on a B-747 are about the same age, and were hired within three years of each other.

As a result of a complicated merger agreement between three unions, a situation also exists where the captain may not only be younger but may also have less seniority than other crewmembers. In addition, recalled airmen are moving into first-officer positions, and show a reluctance to be assertive when required.

The cockpit cultures described above have created a need for improvements in cockpit resource management. Human factors training in interpersonal behavior needed to be introduced to our airmen, and we are convinced that, despite the difficulty in introducing a new program, it is well-worth the effort in terms of improved safety.

Pan Am has committed over $1 million for the initial introduction of our new Flight Operations Resource Management training program.

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CREW COORDINATION CONCEPTS: CONTINENTAL AIRLINES CRM TRAINING

Capt. Darryl Christian
Assistant Chief Pilot

Alice Morgan
CCS Learning Systems

INTRODUCTION

This workshop emphasizes the importance of crew coordination as part of the overall resource management function. The need for such training has received increasing emphasis because of studies conducted by NASA that indicate a link between resource management and safety. John Lauber summarizes the findings of those studies in his paper presented at a NASA/Industry workshop in 1979 and states that: "One of the principal causes of incidents and accidents in civil jet transport operations is the lack of effective management of available resources by the flight-deck crew."

A pilot interview study by NASA indicated an expressed level of satisfaction with technical training, but difficulties with issues such as leadership, crew coordination, and communication within the cockpit.

The NASA studies also included research of the Aviation Safety Reporting System (ASRS) that found problems in resource management in the following areas:

1) Social and communication skills

2) Leadership and management skills

3) Planning, problem solving, and decision-making

4) Role

5) Resources (human and material)

Another significant contribution to the research on human resource management on the flight deck is from Robert L. Helmreich of the University of Texas. His comments stem from many years of research dealing with situational and personality determinants of crew performance. He indicates that "...perhaps our most serious failing in our approach to complex problems of crew performance comes from ignoring the fact that behavior is a function of the *interaction* of the personality and situational factors."

A third source of information comes from Lee Bolman of Harvard University in his research on "Aviation Accidents and the Theory of the Situation." His research provides the basis for the approach we are taking in presenting a model for examining

interpersonal skills and human interaction as a vital element in overall safety and effectiveness in the cockpit.

The Crew Coordination Concepts Workshop is designed to address his recommendations that: "Pilots need to understand the interaction between situations and their own theories of practice. They need to appreciate the distinction between *espoused theory* and *theory-in-use* and be able to explore the possibilities of discrepancies in their own theories. They need to understand the importance of skill in inquiry and on-line learning, and they need to learn theories of piloting that emphasize those skills. They need a conceptual understanding of the interpersonal processes and role issues that are critical to the flight deck situation and they need practice and skill in implementing those concepts." As Bolman suggests, we:

1) Present relevant theory: Contained in a pre-work package and in lecture/discussion form during the work course.

2) Discuss case examples: Contained in the pre-work for study and use during the course.

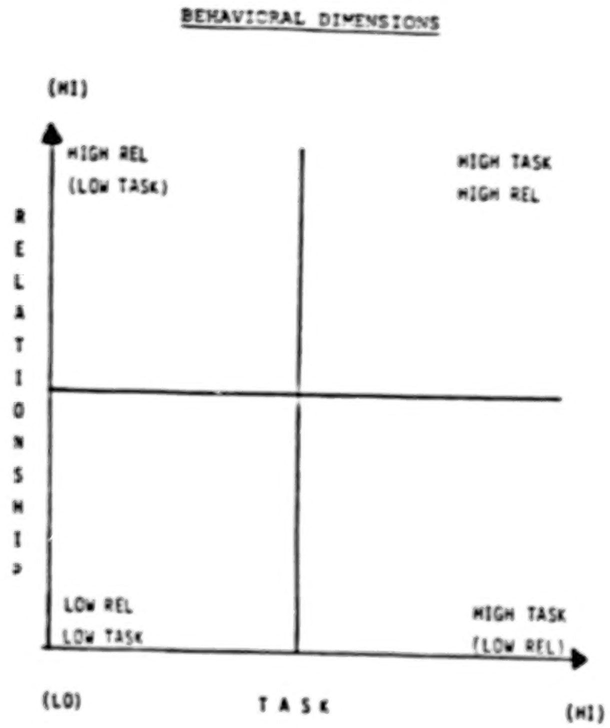
3) Simulate practice problems: Introduced during the course as the beginning of an ongoing process.

OVERVIEW OF RELEVANT MANAGEMENT THEORY

There are many theories about leadership style that have served as points of reference in developing the model that is presented here and discussed in detail in the two-day course. Among the most prominent theories is Douglas McGregor's model of leadership developed in 1960 that has resulted in a standard reference to "Theory X" and "Theory Y" management. According to McGregor, management styles range from *Autocratic* (Theory X) to *Democratic* (Theory Y). A Theory X leader would be directive, structuring, critical, and autocratic, while a Theory Y leader would stress democratic procedures, participative decision-making and self-control.

In 1983 Bill Ouchi introduced his Theory Z, which indicates that managers need to combine characteristics of both styles if they are to be successful in current times. In 1964 Robert Blake and Jane Mouton introduced The Managerial Grid, describing five basic styles, as a way of understanding differences in leadership behavior. In 1969 Paul Hersey and Kenneth Blanchard developed the Situational Leadership model that suggests leaders adopt a style that matches the maturity level of the follower. Works by Peter Drucker and Daniel Yankelovich indicate work-place trends that emphasize the need to be concerned with a better educated and more diverse workforce.

Most of these theories place emphasis and responsibility for success on the manager or leader. Although many different labels are used, all of these theories have one thing in common, i.e., they all present behavioral options on the two basic dimensions of *task* and *relationship*, depicted in the following illustration.



TASK AND RELATIONSHIP MODEL FOR THE FLIGHT DECK

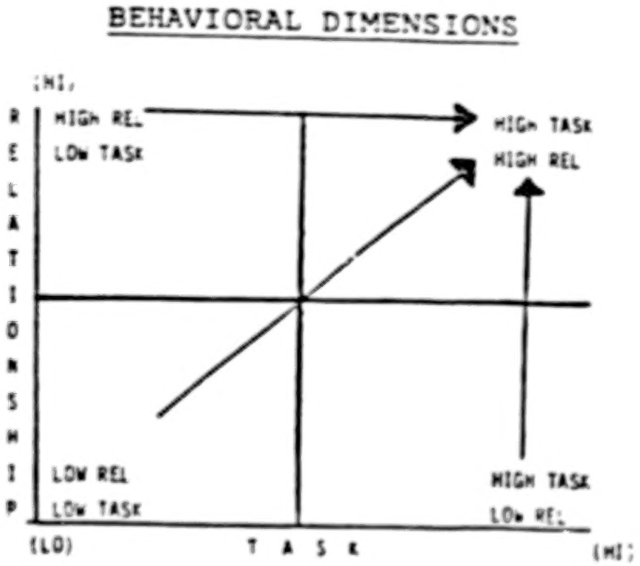
All airlines regularly conduct recurrent technical training which is designed to develop and enhance piloting skills and systems knowledge. Most airlines set very high standards in the area of the technical aspects of being a pilot. The pilots hired must already be skilled before they are even considered. Once hired, a new pilot is provided technical training which focuses on raising both piloting skills and systems knowledge to the maximum. That skill and knowledge must then be demonstrated before the pilot goes out on the line.

As noted in the NASA research, and supported by more recent studies, most flight crew members are competent in the technical dimension, but need a better understanding of their interpersonal relationships.

Because optimum performance on the flight deck depends on cooperation among crew members, we need to pay equal attention to developing interpersonal communication skills to match the technical skill level required. This area becomes more complex because human factors, such as differences in personal style, are harder to define than a concrete set of technical skills.

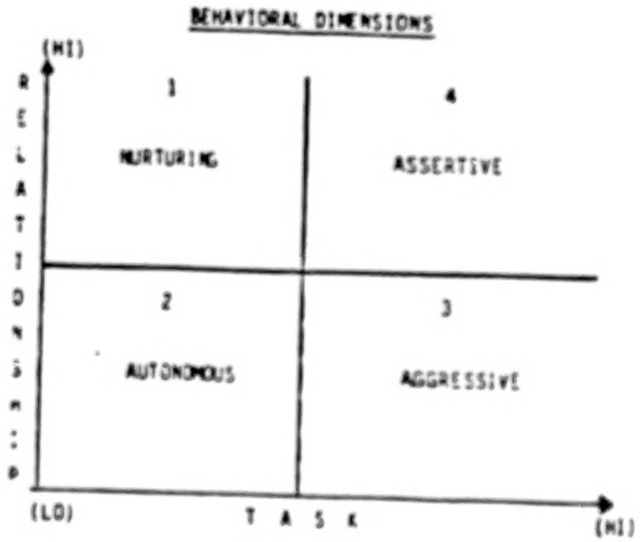
However, if we look once again at the basic *task* and *relationship* model, we can

appreciate the desirability of functioning at the peak of both high relationship-behavior and high task-behavior.



In order to be an effective crew member, each person needs to understand his/her own basic behavioral style *and* the behaviors that are required to perform effectively. While no one behavior is inherently better than another, there is definitely desired behavior in the cockpit.

We can begin the process of identifying four basic behaviors by looking again at the *task* and *relationship* model and applying labels to the four quadrants:



o Quadrant 1 indicates a high level of relationship-behavior and a low level of

task-behavior, labeled *Nurturing*.

o Quadrant 2 indicates a low level of both relationship- and task-behavior, labeled *Autonomous*.

o Quadrant 3 indicates a high level of task-behavior and low level of relationship-behavior, labeled *Aggressive*.

o Quadrant 4 indicates a high level of both relationship- and task-behavior, labeled *Assertive*.

Our contention is that assertive behavior is always the desirable behavior in the cockpit. Assertive behavior indicates highly-developed skills in both task and relationship and is most likely to produce an assertive response from other crew members and ensure the open exchange of information.

As noted above, the review of ASRS reports indicated a need for pilot development in five key areas:

o Communication

o Leadership

o Role

o Decision-Making

o Resources

Communication

We use Bolman's terminology to present and develop communication skills. *Advocacy* and *inquiry* are ways to bring information to the surface when it is needed and are essential to effective flight deck management. All crew members have an obligation to raise issues that affect the safe operations of the aircraft and an equal obligation to be open to the input of other crew members. Developing these skills typically requires changes in one's *theory of practice*. The ability to confront and manage any conflict that might arise from that confrontation develops skill in *advocacy*. The skill of *inquiry* is developed by seeking information from other crew members that would test the assumptions made by self and others. The ideal situation in the cockpit would be where each crew member volunteers information and *advocates* a course of action, and where each remains open to further *inquiry*.

Each person's individual style and theory of practice need to be consciously understood so that conscious choices can be made to effect the desired change in behavior or theory in use. The desired behavior on the flight deck would be to have available the skills to operate at a high level of both *advocacy* and *inquiry*, as required by the situation.

In the workshop, we use a personal styles instrument, the Strength Deployment Inventory (SDI), to help each person understand how they relate to and communicate with others. This instrument explores how relations with self and others can be made more productive and satisfying.

Leadership and Roles

These two topics are combined because of the need to establish role clarity and role flexibility to ensure that each member of the crew is performing effectively.

In an emergency, captains sometimes try to do too much by themselves and to overcontrol crew members. Leadership on the flight deck requires well-developed skills in both task and relationship. As Bolman suggests: "What is needed is a system that preserves the captain's authority to make binding decisions, but places a positive responsibility on other crew members to raise questions or suggest alternatives when they perceive that the captain's strategy might lead to significant error."

Thus leadership behavior is best determined by the situation. In times of emergency, this calls for the ability to surface information quickly and consistently in order to make effective decisions.

Decision-Making

Traditionally, the responsibility for making decisions rests almost entirely on the shoulders of the captain. That responsibility consists of not only making the proper decision, but also of possessing all of the knowledge necessary to make the proper decision. The captain on today's flight deck *still* has that ultimate decision-making responsibility. That has not changed. What has changed is that the other crew members on the flight deck are being asked to accept more responsibility in helping and assisting that decision-making process by communicating the knowledge they possess regarding a particular situation. Obviously, the more knowledgeable input there is into making a decision, the better the odds are that the right decision will be made.

Resources

The importance of using all resources has been repeatedly stressed in reviewing aviation accidents that could have been prevented *if* the crew had made optimal use of available resources. An example is the worst accident in history, the collision of two B-747s at Tenerife. In that accident, the KLM captain began his take-off roll despite his copilot's suggestion that the runway might not be clear. This course examines the elements of desired cockpit behavior that could prevent this kind of example.

Summary

Improvement of resource management is the purpose of this workshop. Review of accidents and NASA studies indicate the following common factors as the most frequently observed problems:

- o Preoccupation with minor mechanical problems

- Inadequate leadership
- Failure to delegate tasks and assign responsibilities
- Failure to set priorities
- Inadequate monitoring
- Failure to utilize available data
- Failure to communicate intent and plans

These findings support the need to emphasize the human resource management aspect of flight deck management. A commitment to safety includes a system that ensures the technical capacity to respond to all situations in the cockpit. In this course we emphasize the equal importance of understanding human resource management by presenting the concepts of Assertiveness, Theory of the Situation, Testing Assumptions, Active Listening, Norms, and Critique that will help aviators build these relationship skills.

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OPTIMUM CULTURE IN THE COCKPIT

Capt. Hisaaki Yamamori
Japan Air Lines, Ltd.

Good afternoon ladies and gentlemen. I am very pleased to be able to participate in this cockpit resource management workshop.

As you know, about two years ago the International Civil Aviation Organization (ICAO) issued an "Accident Prevention Manual." In this manual you can find the following summary:

> "If the air transport accident rate remains static, and the volume of air transport continues to grow, the number of accidents each year will increase. In addition, aircraft size and capacity continue to escalate. Thus each accident will involve, directly or indirectly, more and more people and the associated financial (and social) costs will rise proportionally. If the traveling public is to continue to regard air transport as having an acceptable safety record, then the current accident rates must be reduced."

This will not be an easy task. The ICAO Manual also states: "While the goal of accident prevention is the elimination of all accidents, the fallibility of human nature makes this goal unobtainable." However, we must do the best we can. In the future, if we are to succeed in significantly reducing the accident rate, it will be necessary to go well beyond simply trying to minimize human error. We must also focus our attention on all aspects of human nature. (Slide 1)

I would now like to take some time to look back on the safety of aviation. As all of you know the trend of international air transport accidents has been shown by ICAO. (Slide 2)

This chart shows the trend between 1950 and 1980. The figures indicate the number of passenger fatalities in aircraft accidents for every one hundred million passengers who fly one kilometer. The fatality rate for 1950 was 1.97 persons. It then declined markedly to 0.78 in 1960 and to 0.18 in 1970.

The fatality rate for 1975 declined further to 0.08, or one twenty-fifth of the 1950 level. While the overall accident rate has decreased significantly, from 1975 the rate has leveled off to indicate that different methods and more effective safety methods are necessary.

There is another chart that clearly shows the facts. This chart shows the relative trends of accidents resulting from machine causes and from man causes. (Slide 3)

We can see that a great change has occurred in the relative percentage between machine-caused and man-caused accidents. Machine-caused accidents have declined,

while those caused by man have increased. The decline in machine-caused accidents is a direct reflection of a remarkable improvement in the performance and reliability of aircraft equipment.

Indeed, aircraft performance is now approaching the highest possible level of modern technology. A great improvement can also be seen in hardware, airport facilities, ATC systems, and so on.

Presenting a sharp contrast is the steady rise in the proportion of man-caused accidents. This may show that there has not been much improvement in human ability from olden times. We have spent much time and research to improve our aircraft in order to make them more reliable, but less efforts and attention have been given to the officers in the cockpit.

Perhaps some people would say that this accident trend is quite natural, because it is the cockpit crew which has always been required to perform difficult tasks which cannot be done by a machine. Therefore, since the most difficult tasks must be completed by the crew, the machine-caused accidents are low on the chart and the pilot does not do so well.

At any rate, judging from this chart we can say that it is absolutely necessary for us to make every effort to eliminate accidents caused by human factors if we are to improve flight safety performance still further by substantially reducing the aircraft accident occurrence ratio.

It is generally understood that the effect of measures taken to eliminate accidents appear suddenly or abruptly. Then the curve tends to level off as time passes. (Slide 4)

As far as flight safety measures are concerned, emphasis has so far been placed on two points. The one is on improving the reliability of flight equipment by correcting mechanical defects. The other is on selecting the best-qualified candidates for pilots by improving the aptitude tests for flight crew candidates. However, even if the best are selected, it is virtually impossible to keep a pilot constantly in an optimum state in relation to the aviation system because the systsem changes rapidly as time goes on. (Slide 5)

It is easier to improve technology than to review and improve human factors. The result is that the solution to the problem of human factors-related accidents are always left to the last. As a matter of fact, we must admit that the problems of human factors have so far been more or less neglected, compared with problems relating to aircraft technology. Japan Air Lines is no exception. (Slide 6)

In 1977, Japan Air Lines had a DC-8 accident at Kuala Lumpur in Malaysia. The aircraft involved in this accident had flown from Hong Kong to Kuala Lumpur. The accident occurred because the captain of the aircraft descended below MDA without having the runway in sight. He continued the descent until the aircraft struck a hill 260 feet above mean sea level. It was four nautical miles short of the runway threshold. (Slide 7)

A subsidiary contributory factor was insufficient instrument monitoring of the aircraft's flight path by the captain during adverse weather conditions, with several other aircraft holding awaiting their turn for approach. But a more important factor can be said to be the first officer's failure to challenge the captain's breach of published company regulations.

After this accident, the company set up a committee for the purpose of studying overall safety. This Committee was called the "Critical 11 Minutes Committee"--the eleven minutes consisting of three minutes after takeoff and eight minutes before landing. In its studies, the committee discovered that human factors were indeed a major problem and a cause of accidents. It also found that these problems do not come from or begin with technical or pilot skill, but stem from:

- Misjudgement
- Lack of knowledge
- Poor crew coordination
- Deviation from standard operating procedures
- Influence from outside factors (Slide 8)

Although this committee pointed out the need for understanding the human factors involved in the cockpit environment, nothing was done at that time because there was no concrete way existing to solve the human factor problem.

In 1983, we established a Human Factor analysis group because of a rise in human error-related accidents and incidents. This analysis group developed a checklist to be used for all company incidents after the Kuala Lumpur accident. (Slide 9)

We now have 50 cases on file including such items as:

- Taking-off without clearance
- Outboard engine hit runway when landing
- Because of the wet runway condition, an aircraft slipped and a taxiway light was broken by the nose gear. (Slide 10)

We found that since 1977, when the Critical 11 Minutes Committee was created, there have been few or no changes made to eliminate the human factor error. We also found that most of our incidents were caused by:

- Poor crew coordination
- Inadequate briefing
- Failure to use accepted procedures

- o Inadequate coordination or timing

- o Delay in taking necessary action (Slide 11)

Up to that time, we had two hull-loss accidents. One was the Tokyo Bay accident caused by the captain's mental incapacitation. (Slide 12) The other was a plane that overran the runway at Shanghai airport due to a rupture of the airbrake bottle which caused some system damage. (Slide 13)

A Fault Tree Analysis (FTA) was used for a detailed analysis of those accidents. The Fault Tree Analysis is basically a logic diagram that attempts to show the complex processes and relationships involved in an accident. It is adapted to show the cause-effect relationships that induce accidents. The FTA thus assists in identifying and tracing the chain-of-events that lead to a system failure. (Slide 14)

This figure is an example of the FTA charts of our Tokyo Bay accident. It includes the symbols commonly used in constructing such a flow diagram starting with the accident at the top of the page and working downwards. The FTA can be considered to progress backwards through different levels via "And" and "Or" gates in response to the question "Why"? The branches become more detailed as all available information is added and leads to basic causes or hazards. In our studies, it almost always arrives at a common cause--that of "human error."

Of course during this period we were also studying for an effective human factors training program, but because of a lack of aviation psychologists in Japan, we looked elsewhere for a suitable human factors program. Our search took us everywhere in the world.

I spoke with many human factors specialists, including government officials and university, military, and nuclear power human factors specialists. However, we were not completely pleased with what we saw. We might have given up our search long ago but we had the great advantage of knowing exactly what we needed.

At that time, in 1983, I received a letter from Capt. Carroll explaining the CRM program developed by United Airlines. The letter stated that Japan Air Lines was facing the same problem that UAL had in 1979. Capt. Carroll suggested that a cockpit management training program would be helpful in addressing the problem of safety in the cockpit.

At the beginning of my own CRM study, I had a basic question about this program which had been developed by American researchers. Because of cultural differences, I questioned whether this type of western-style training program could be adapted to the Japanese way of thinking, especially since the program deals with "human behavior" problems.

Because America is a leading country in the field of behavioral science and there are so many aviation psychologists and researchers, this dilemma could not be ignored. I began observing the differences between American and Japanese pilots.

From my experience of working with American pilots in the UAL public seminars, I feel that American pilots are more task-oriented than are Japanese pilots. Their behavior contrasted with the behavior of Japanese pilots at our seminar in Japan where the Japanese tended to behave in a more group-oriented fashion. (Slide 15)

Therefore, from my study I see America as a task-oriented society. The people seem more aware of themselves as individuals rather than as part of the group. The American culture seems to encourage the individual independent self, while the Japanese culture encourages the development of the dependent group-oriented person.

Japanese modesty is not seen as a virtue in the American culture. In the team discussions during the CRM seminars, I felt that the Americans did not easily accept another person's opinion, whereas Japanese tend to accept another person's opinion whether right or wrong in order to preserve harmony within the group.

Americans will sometimes aggressively support their own opinion, even if they are not entirely correct, because they are competitive and see the situation in terms of winning or losing. In contrast, the Japanese will usually become silent and non-supportive of their own ideas if they see some opposition to them.

Another important point is that Japanese are often conformists who need to identify with a group. Japanese rarely will try to stand out and be creative in a group situation. This is because we want to achieve a sense of harmony. It is a part of our history and our culture. About 1400 years ago a famous Japanese prince called Shotoku Taishi said "the harmony is to be respected." His words and this thought are still alive in the Japanese mind.

Of course, the Japanese are also a competitive people. However, they differ from Americans in that their competition is directed towards an outside group or organization. While the Japanese are very competitive towards each other in their own minds, they will never express that competition verbally.

In our Japanese society, acceptance is highly valued and is achieved through a person's efforts for his group. His efforts, whether useful or not, are seen as his merits and will earn him respect and promotion even if he has little real ability.

Although I saw those differences in our cultures, I realized that in the cockpit situation neither the Japanese way of behavior nor the American way are the best.

I don't think that any culture--whether it is Japanese, American, or any other--fits in with the cockpit environment. And in this sense, cockpit resource management is culture-free. (Slide 16)

There are many situations where authority is shown in the cockpit. There are also times that cockpit authority must be questioned or challenged. And it is in this type of challenge situation that crewmembers react differently based on their cultural background.

Authority is rarely challenged in a group-oriented society. But as we in the airline

industry know, this kind of attitude has led to many fatal accidents. On the other hand, in a task-oriented society those in authority may fail to listen to the opinion of others when their authority is challenged. This too has led to fatal accidents. Let me explain this through the use of a "grid." (Slide 17)

As I said before, my feeling is that American pilots are task-oriented and Japanese pilots are mostly group-oriented. Both, of course, have the same goal in mind--that is, the goal of ultimate safety. (Slides 18 & 19)

Even with the same program and objectives, if the culture is different, there will be different approaches to the goal. However, the cockpit environment is culture-free so it is not as important to think of a person's cultural background as it is to think of the approach to the goal of ultimate safety. Crew members can look at their individual safety goals and compare them to their own performance to see if their behavior matches their own safety goals.

After three years of extensive planning and working closely with UAL, we finally began our in-house CRM-LOFT training program for all crew members. We hope to have trained all our crew members within two years. We hope, that after applying CRM to our flight training program that our crew members will realize that the very Japanese attitude towards authority does not belong in the cockpit environment. (Slide 20)

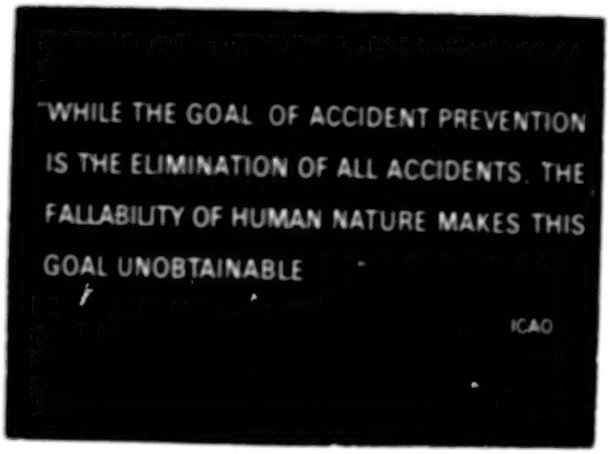
The cockpit environment must be culture-free in order to obtain our ultimate safety goal. I think we must first realize how our culture affects our behavior before we can begin to change our attitude and actions in the cockpit.

And finally ladies and gentlemen, I would like to read this statement from ICAO's Accident Prevention Manual. (Slide 21)

> "If in the future we are to succeed in significantly reducing accident rates, we must significantly increase the efforts to determine and understand the reasons why people behave, act, or respond in the way they do. Only then can we hope to effect some fundamental improvements in the safety record."

Thank you very much.

SLIDE 1



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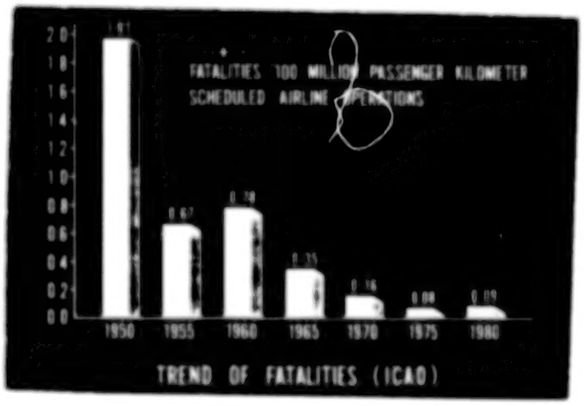

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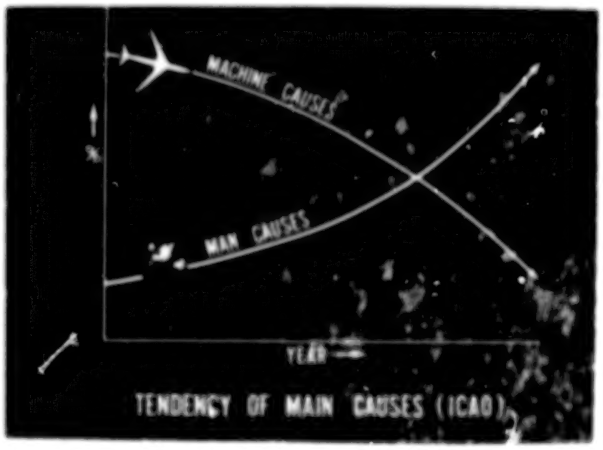

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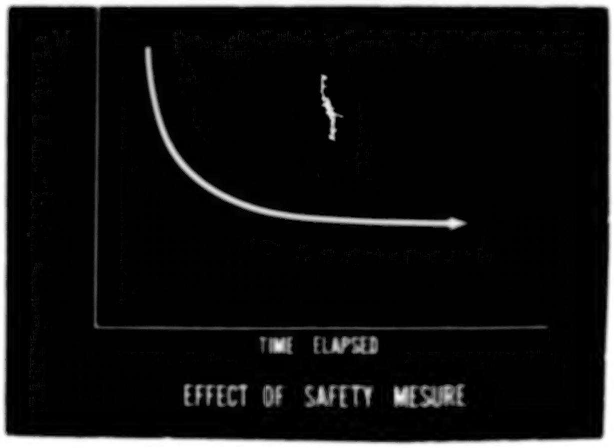

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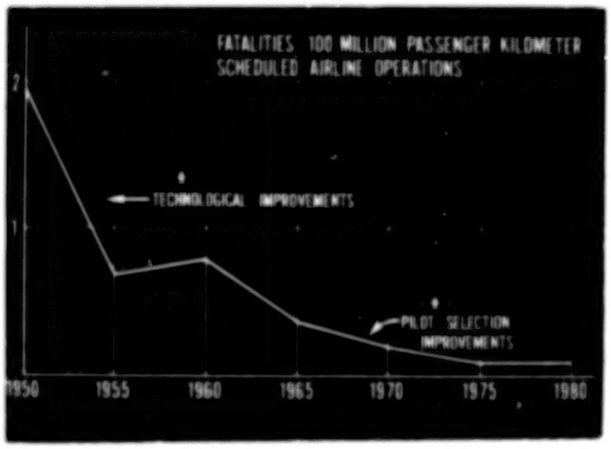

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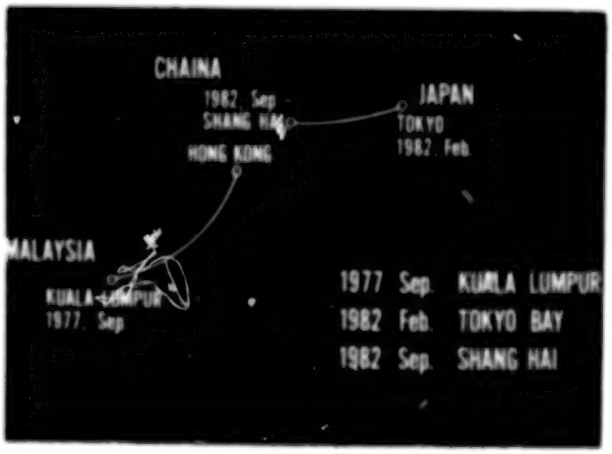

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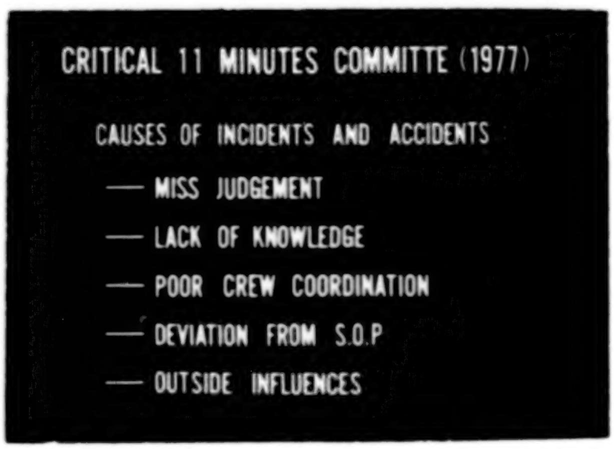

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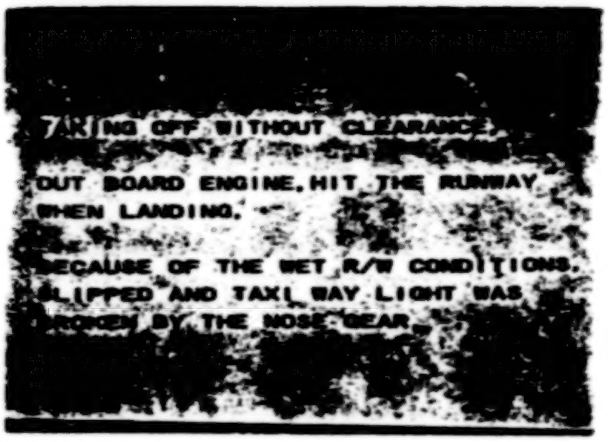

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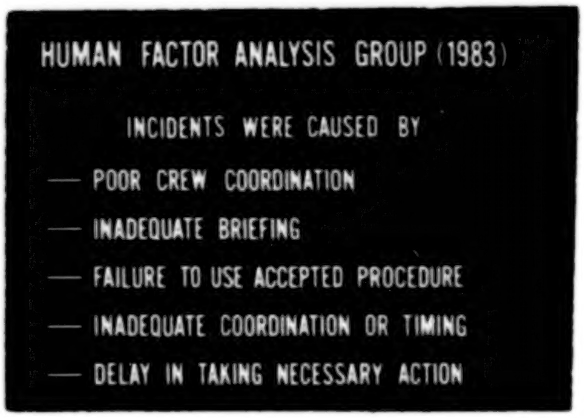

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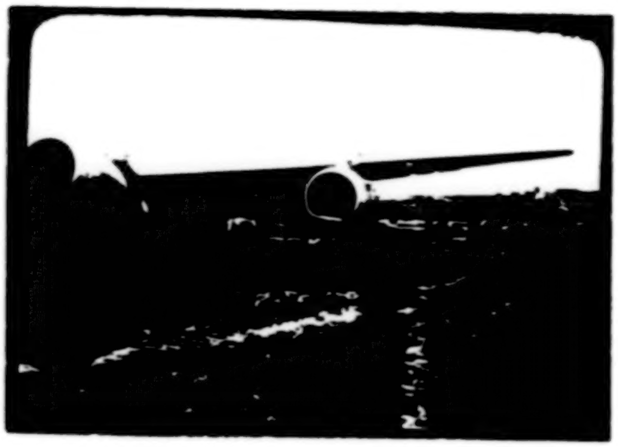

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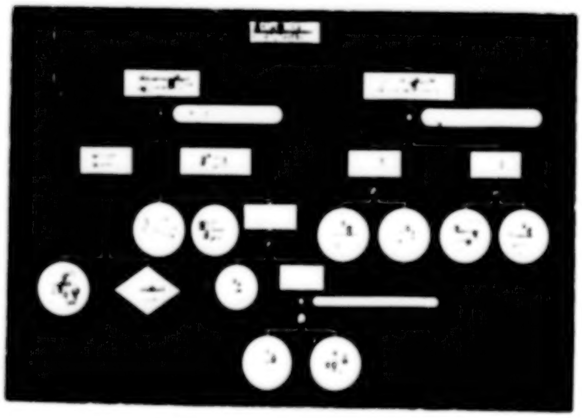

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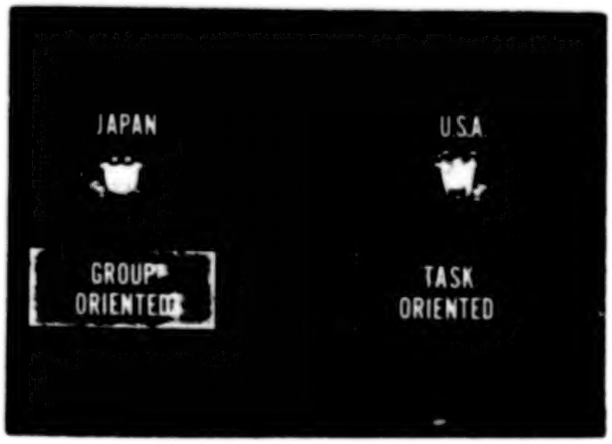

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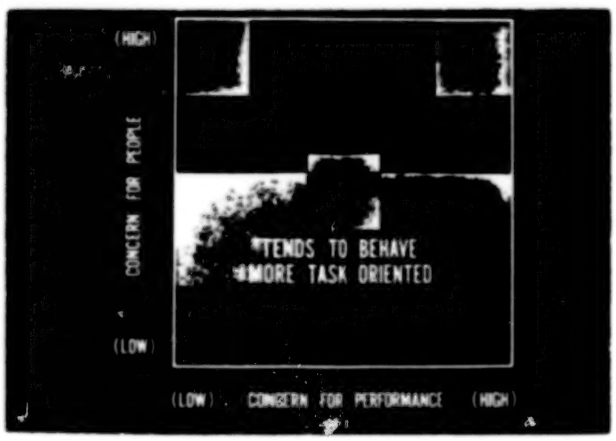

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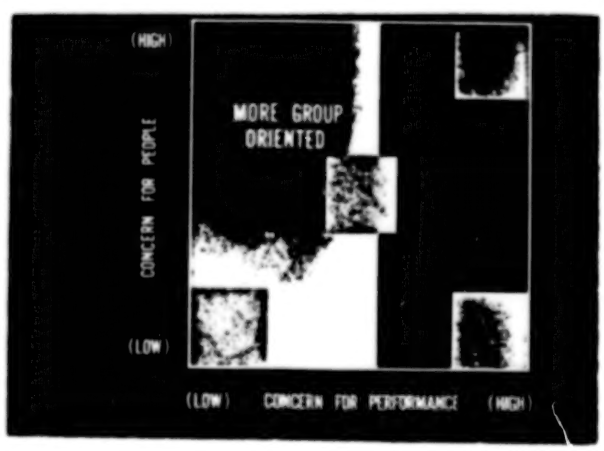

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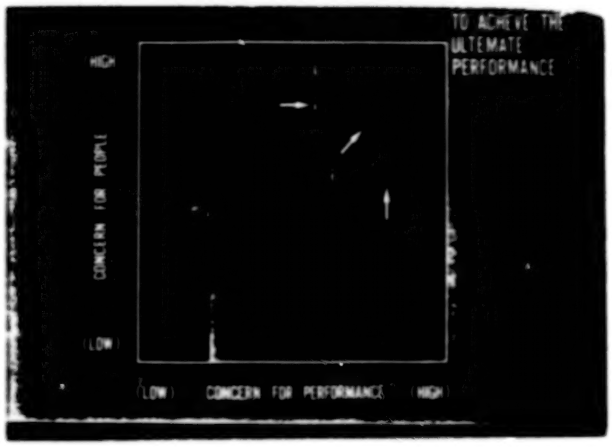

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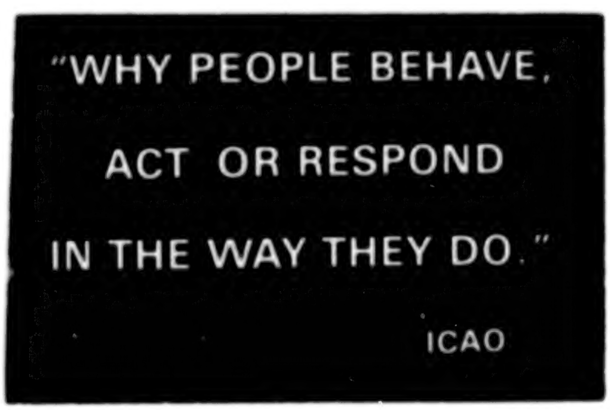
SLIDE 21



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INTRODUCTION TO TRANS AUSTRALIA AIRLINES CRM TRAINING

Capt. Jim Davidson
Trans Australia Airlines

Good afternoon, ladies and gentlemen. I would like to do something a little different by starting to talk to you about vitamins. Vitamins are normally taken by people who are not sick, in the fond hope they won't get sick--that they will preserve their good health. Lots of people will say that they are rather useless and that a normal diet will render any vitamin supplement unnecessary, and that may be right.

The other thing about vitamin pills is that probably you will never know if you don't get sick whether it was the vitamin pills that are responsible for your continuing good health.

All that leads me to the discussion of Cockpit Resource Management and certain similarities. Most airlines that are considering adopting a form of training along these lines are not, in those terms, sick. Perhaps, some of them have had an accident rate which is concerning them, but generally they're looking at it as a preventive rather than as a curative force. There are many people that will tell you that it is unnecessary.

When we put the proposition to our own flightcrew members at Trans Australia, many of them said, "we don't need this type of training", and suggested that the management who even contemplated it needed to take the training.

Finally, as we will be talking about it in working groups, the question of evaluation as to whether this type of training is ever going to prevent an accident will be of some interest to us. It could well be that the accident that you never have you might attribute to the resource management program, but you may never prove it. So I have my analogy close to the program.

We at Trans Australia are fortunate that we are healthy in those terms. We have an excellent safety record. We have not had a loss to even begin statistical measurements, since we are not running a great number of aircraft and have had only a few, very minor, propeller-aircraft accidents.

We believe that our accident-rate record is due to a number of factors. We have a good group of standard operating procedures, and our crews are pretty well self-disciplined and adhere to those procedures. But the other thing that we, perhaps with all good modesty as one of the other experts said, believe is a factor in our safety record is that perhaps it is also due to our preparedness to be innovative, to keep up with what is going on in the rest of the world and, if it looks to have value, then to be amongst the first to try it out.

You have heard all about LOFT today. We were very early users of simulators, beginning in the 1960's. In those days, a LOFT was a small thing on the top of a house.

We commenced a program similar to LOFT fairly early in 1979--that being our first windshear program--so that leads me to why we are doing a course of resource management training, which we have chosen to call "Aircrew Team Management" (ATM).

The previous speakers have very adequately dealt with the reasons for these programs. We attended most of the seminars and workshops that have been referred to, and we are well aware of what other airlines have been doing. We have attended a number of other courses, and we are aware of such work as the "Q" effect, CRM, and others either through direct attendance or by acquainting ourselves with written or other material.

Captain Yamamori referred to a cultural difference between the United States and Japan. You may find it difficult to believe, but there is also a cultural gap that has crossed the Pacific to the southwest.

So the outcome was that we decided, since we couldn't buy an off-the-shelf type program that would suit our needs, that we would take some remarks made at the Montreal IATA training programs a year ago seriously. They were essentially, "we don't ask you to go to our program, but please do something."

I took the United course about three years ago--the Godfather CRM, if you will permit me that description. And rather than going the way of "make me an offer I can't refuse," we decided that we would take the advice we got at Montreal and would do something, and would produce a course which was tailored to our own needs.

We were fortunate at this point in that, fairly coincidentally we came in contact with the Queensland University School of Management, who were then conducting senior management planning for our administrative management. My boss, the training flight manager, got together with Professor Charles Margerison, who was teaching one of these courses, and their discussion led to a whole program that suggested that the type of training in which they specialized could be adapted to the cockpit environment, and that between us we might be able to work out a course that exactly met our needs.

So I would like to now turn our presentation over to Charles who will give you the background of our program. Charles is the Director of the design team that we worked with in producing our ATM course. The other members of the team were Dick McCann, who is also with us today, and Rod Davies.

Charles is in professional management at Queensland University, which is a major university in one of our large capital cities. He has a doctorate in educational psychology, and he also has a practical background in designing management improvement programs, with such organizations as Mobil, Kodak, Shell, and Citibank. It was that wealth of experience that we valued and used in asking Charles to assist us in establishing an innovative, and peculiarly Australian, ATM program.

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AIRCREW TEAM MANAGEMENT PROGRAM

Flight Standards Division
Trans Australia Airlines

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INTRODUCTION

This paper is designed for circulation at the NASA/MAC Workshop on Cockpit Resource Management in the Cockpit, May 1986. The paper outlines the key features of the Aircrew Team Management Workshop which we have designed for and in consultation with Trans Australia Airlines. The paper will be in five major sections dealing with:

A) A Profile of the Airline and the Designers

B) Aircrew Consultation and Involvement

C) Educational Design and Development

D) Implementation and Instruction

E) Evaluation and Assessment

SECTION A: THE AIRLINE AND THE DESIGNERS

Trans Australia Airlines (TAA) is a government-owned airline flying to all major cities and towns within Australia and operating on some international routes in the West Pacific. It has a fleet of Fokkers, DC-9's, Boeing 727's and the Airbus 300. There are over six hundred pilots and flight engineers.

The airline has a first-class safety record. It was to maintain and enhance this safety record that the senior management of the airline decided to introduce special training for crew members on teamwork issues, given the evidence that human factors

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are a major cause of aviation accidents and are regularly mentioned in incident reports. The program called Aircrew Team Management (ATM) is described here in the critical context of its design and development.

Following a 2-year review of other cockpit human-factors programs, the executives in charge of the flight standards department of Trans Australia Airlines decided to adopt a "tailor-made" rather than an "off the shelf" approach. TAA developed the objectives for such a program and invited us as educational designers and architects to submit proposals based on our successful work with other large organizations in the oil, banking, manufacturing industries and other sectors. We had no previous experience in the aviation industry, nor did our team have any knowledge of flying. Our expertise and experience lies in educational design and technology combined with a strong background in organizational and social psychology. One of our areas of strength is team development. We have created a wide range of technology to enable individuals and teams to identify how they can improve their performance. It was this social technology for developing team skills that led the airline to establish with us a joint venture on Aircrew Team Management.

SECTION B: AIRCREW CONSULTATION AND INVOLVEMENT

The Critical Importance of Consultation

We started the project by establishing a consultative network amongst aircrew. Our aim was to find out the key issues of effective and ineffective cockpit management as perceived by line pilots and flight engineers, as well as by check airmen. This was clearly essential for our understanding, but of even greater importance was the commitment it engendered through the involvement of line crew. The process of consultation is often overlooked or ignored and crew are sent on courses designed "for them" rather than "with them". The result is imposition rather than cooperation.

We therefore tried to get as wide a representation as possible in our meetings. We had a number of consultative group meetings which included over a hundred aircrew, union and management representatives. Thus we were able to ensure that all the major issues of concern were included in the final design. The various consultation processes supported by the senior management of TAA are outlined below.

The Steering Committee

A group, comprised of management and line flight crew members, representatives of both the pilots' and engineers' unions, plus the three university design team members established the Steering Committee. This group met regularly on a monthly basis during the early phases to set policy and guidelines and provide a two-way consultative channel.

Workshop with Check Airmen

An intensive two-day workshop with a sample of check airmen was conducted to gather their views and opinions on the key team management issues they felt should be

addressed.

Meeting with Line Crew Representatives

A larger meeting was held for two days with flight engineers and pilots on all aircraft types, to ascertain their views on the need for a training program. Initially they were openly hostile to the idea and skeptical and cynical as to its value. We listened carefully. The aircrew were not prepared to cooperate until they felt we had recognized and appreciated their feelings on training generally and organizational issues in particular. Once this had been done they provided very valuable information with case examples and agreed that we should continue our discussions with them .

Remuster of the Line Crews

After the first line crew meeting we sketched out a preliminary design for the program based on educational design principles and what we had picked up from the meetings. We then met the group again in a one-day meeting and asked them to debate our initial design and put forward constructive proposals.

On this occasion the meeting was more positive and oriented toward specific problem-solving. The members attending also included senior union representatives and by the end of the day most participants were sufficiently well-disposed to the initial plan to go forward and talk positively to their colleagues. We believe this part of the consultation process was invaluable in gaining overall acceptance of the final design.

Flight Standards Meeting

At the annual meeting of all those involved in flight training and checking an opportunity was provided for one of the design teams to outline the initial plans and gather the reactions of the sixty members attending. This proved to be a successful consultation process. Most of the senior pilots and flight engineers attending were impressed that the training workshop would be based upon real issues involving their own airline rather than a system which had been imposed from outside.

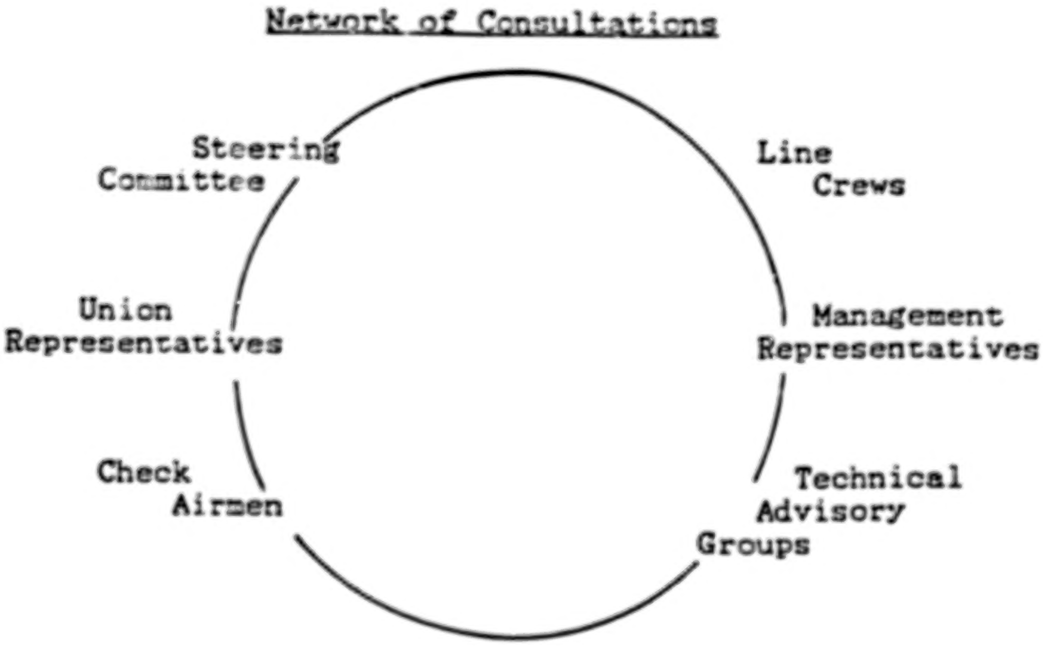
Other Consultative Efforts

In addition a questionnaire was circulated to all aircrew. However, there was a reluctance amongst aircrew to reply to this and a very low response rate was gained. Clearly the personal meetings in which people could talk were favored rather than each person having to write things down.

A number of other opportunities for consultation, which in retrospect could have been very important were planned, but for various reasons did not occur. It was, for example, planned to have airport meetings with pilots. However, these were initially postponed and then later cancelled due to organizational difficulties.

The major lesson which we learned is that consultation is not a luxury or something that you add on if you have time. It is an essential prerequisite to any successful aircrew training initiative. The very fact that aircrew members were involved was a

vitally important ingredient in gaining their support and commitment to the whole venture. In all, we involved about 100 aircrew in the pre-program briefings and discussions. These people set the climate of opinion amongst their colleagues that ATM was worth considering and that helped change some peoples attitudes towards a more open-minded approach. We believe this was critical in acceptance of ATM.



Reactions from the Aircrew

Comments from aircrew members early in our involvement indicated the lack of support that had to be overcome. One comment that received general support was, "there are a lot more important issues which management should be dealing with before they put us on a course on cockpit management". Another line crew member suggested, "senior members should go on a management course before they put us through one". The consultative process therefore indicated clearly that the line crews were not initially enthusiastic about a cockpit management program. They saw the TAA safety record as one of the best in the world and therefore strongly questioned the value of spending money in this area. Some pilots also saw the intended program as a "slight on their professional ability".

Through discussion and consultation these issues and concerns were thoroughly debated and people's feelings and frustrations were freely aired in the line crew workshops. We were asked to illustrate some of the methods for developing more effective teamwork and in the end commitment grew through involvement.

Therefore we would strongly urge any airline contemplating ATM training to take the time and the trouble to consult directly with the line crew. Many of the comments and views that they express will not always be supportive but if they are recognized and

understood, such points can make an enormous contribution to the end result.

There may be an inclination by airline management to implement a solution once it is available because they have lived with the problems for such a long time. They feel they already know what is required and therefore only need the method. Indeed, the line crews we consulted felt very much that they knew what the problems were and could also advance many of the solutions.

However, and this needs to be stressed, our consultative procedures were the first time that captains, first officers and flight engineers had been brought together in the same room to discuss the specific issue of cockpit management. Because of the nature of the job and the contract arrangement for their employment it is not the norm to have line crews meet and discuss in depth how cockpits are managed. The consultative approach adopted clearly reflects the support of the present senior management of TAA for this approach and indicates a change from the previous style and culture.

Beyond these consultations we also did considerable research looking at incidents and accidents on a worldwide basis.[1] From this we identified a key list of issues which we put to the pilots of TAA to see if these reflected the sort of issues which should be incorporated into an aircrew team management program. The list that we produced has been summarized below and reflects in brief the particular points that we addressed in our educational design.

SOME EXAMPLES OF TEAM MANAGEMENT PROBLEMS IN THE COCKPIT

Lack of Support - where one crew member fails to back up another, during high workload situations.

Standard operational procedures ignored - for example, where the captain and crew fail to complete a checklist under time or other pressures.

Stress problems - where a crew experiences difficulty in adapting to unusual emergency situations.

Judgement problems - where management of priorities and cockpit distractions distort the judgement process.

Emotional problems - where aggression or extreme submissiveness in the cockpit affect personal relations, or where there is a carryover, for example, of domestic worries and conflict to the job.

Get-home-itis - where failure, for example, to divert or "go round" in risk situations occurs.

Management pressure - where there is a deferral to management authority, for example, in expediting departure before the crew is sufficiently prepared.

Discipline problems - where corners are cut and there is inadequate control of operations in the cockpit.

Leadership problems - where the captain does not delegate adequately.

Communication problems - where there are misunderstandings or lack of conversation control.

These were some of the key areas that crew members agreed should receive attention in any specially-designed workshop. It was upon this and other data that we therefore began the process of design.

SECTION C: EDUCATIONAL DESIGN AND DEVELOPMENT

We started the assignment on a consultative basis and this was continued also at the design stage. The first step in this was to work with the Steering Committee on the broad policies and principles governing the training workshop. The Steering Committee discussed in detail the key issues arising from the research and came to agreement on the main features of the workshop such as the length, the content, and the learning methods to be used.

The Technical Advisory Groups

A major decision of the Steering Committee was to establish several Technical Advisory Groups. These groups were made up of line pilots and flight engineers who were seconded on a part-time basis to work with the design team in providing specific cases and illustrations. This became a vital part of the whole design process. The actual content of the workshop was heavily influenced by the Technical Advisory Groups. Also, cases and program material could be continually checked for technical accuracy and relevance.

A particular example of this was in the construction of five videos which were made to simulate particular incidents in aircrew team management. All five incidents were based upon in-depth discussions with advisory group members. These members were directly involved with the design team and assisted with the preparation of scripts for the videos. Moreover, when the videos came to be made in the television studios, three pilots made themselves available on a voluntary basis to attend sessions at which filming took place and to give the actors technical advice on their roles.

The realism and high technical quality of the videos is a testament to the detail and attention paid by the Advisory Group members and the professionalism of those involved in producing the videos. The design stage is a make or break process in any

training innovation. It was certainly so in this particular event. Although we had gathered a considerable amount of information from aircrews, we now had to mold this into a practical and relevant framework which would be of benefit to them in their jobs.

Content Issues

As a result of our consultative meetings, it became clear that there should be three major features which required priority in any teamwork training program. These dealt with personal understanding, skills of working with other people, and skills in organization. The box below summarizes the key points.

AIRCREW TEAM MANAGEMENT

Key Elements

Issues	Methods
1. UNDERSTANDING ONESELF & OTHERS	- PERSONAL PROFILES & - DISCUSSION VIA THE TEAM MGMT. INDEX
2. COMMUNICATION SKILLS	- CONVERSATIONAL CONTROL - COMMUNICATION STYLES - EXERCISES & ROLE PLAY
3. TEAM SKILLS	- TEAM WORK & DECISION- - MAKING SIMULATION

After discussion with the Steering Committee and Technical Advisory Groups, it was agreed that these items should form the basis of the program and that specific examples, illustrations, applications, and models should be designed to bring these areas to life. It was at this point that we began to mesh educational technology with the aims of the program.

Scheduling and Location

Trans Australia Airlines arranged for the ATM workshop to be a three-day live-in event held at a residential training college pleasantly situated on the shores of Port Phillip Bay in Melbourne, Australia. It was felt important the event should be away from the airport and the usual technical training facilities. It was also noted that the crews were not predisposed to the classroom situation and that they would react unfavorably to long periods of lectures by "experts". It was important to reflect the real issues that take place in the cockpit, in a practical and participative educational design.

Video Simulations

One of the main ways we reflected the work of aircrew was to produce videos on five flight situations. These videos were shot in the simulators, at airports and in the studio. In all, about 50 minutes of video are used over the three days, as models of effective and

ineffective teamwork. Learning by observation (behavioral modeling) is an important principle of adult psycho-educational design and it is discussed in more detail in one of our supporting papers on ATM.[2]

The issues identified in the videos are the way in which an aircrew deals with such problems as:

- o a delay and rescheduling before take-off
- o a critical situation occurring at take-off
- o a critical problem such as a fire at cruising altitude
- o difference of opinion between crew members on landing
- o a conflict occurring in a two-person crew.

These videos are designed to show both effective and ineffective practice but concentrated more on the latter to highlight the particular problems that need to be overcome. It is noteworthy that crews have since indicated that it would be extremely valuable to have another video made which shows major problems where the crew handle them in "copybook" style. However, in our experience videos containing a mixture of good and bad points promote better discussion.

Group Discussion Time

Associated with the videos, which are shown at particular points on each of the three days of the workshop, are group discussions in which the participants have an opportunity to discuss in detail the issues of team management. They feed back their views to plenary sessions and also have workbooks where they can make comments and note their suggestions for improving the performance of the cockpit crew shown in the video.

Role Play Skill Practice

Another key feature of the design which enhances the active participation of aircrew are the role plays. This is a commonly-used technique in management courses but is not extensively used in aviation. It enables people to both experience and practice new ways of relating while reinforcing the old, well-established methods that have been proved to work. The role play situations again try to reflect real-life dilemmas and problems in the cockpit as well as those encountered with management outside the cockpit.

Rather than just asking aircrew members to become actors we provide throughout the workshop key guidelines on techniques that can be used to enhance performance in such situations. Particular attention is paid to the techniques of conversational control and communication styles. This work, which has been developed by the authors, has been specially adapted for aircrew members and special materials have been prepared.

KEY ELEMENTS OF THE PROGRAM

Understanding Oneself and Others

A major feature of the ATM program is the opportunity for participants to gain greater self-understanding and a framework in which to understand themselves and others more clearly. This has been done through use of the Team Management Index--an instrument designed by the authors and is used internationally by organizations such as Hewlett-Packard, DuPont and Shell.[3] We have tested the Index for its reliability on an aircrew sample and adapted the profiles specifically to the needs of aircrew.[4]

The Team Management Index is a sixty-item questionnaire which is based around four key factors dealing with:

- o how people relate with others
- o how people gather and use information
- o how people prefer to make decisions
- o how people organize themselves and others

These are key issues in any cockpit where people have to establish good working relationships, share information, make decisions and organize operations.

After the Team Management Index is completed, the results are fed into a computer software program and each participant receives a 3,000 word personal printout outlining their own work preferences within the context of a model which enables them to understand how they relate with others. Initially there was a high degree of skepticism amongst aircrew members to this idea prior to seeing it in practice. They objected to the use of anything that looked like a "psychological instrument".

The subsequent reaction is the very opposite of the original concern. Aircrew members find the profiles particularly helpful as indicated later in the assessments that they have made. A large number of the participants particularly pointed to the value of having a practical way of gaining self-understanding and being able to have a better understanding of colleagues. There is now no objection to the use of the Team Management Index and it is generally regarded as an integral part of the overall program.

Communication Styles and Skills

Attention is also paid to communication styles. A major input here involves the presentation of a model with practical advice on how to deal with the aggressive or submissive crew member and how to become a more assertive and supportive team member. Again, these principles are reinforced by group discussion, behavioral modeling, role play and team exercises.

Cockpit communications is a key to effective teamwork and needs to go beyond a general understanding of styles. Considerable attention is therefore given to communication skills. Major communication skills are outlined in the Conversational Control Model. Exercises are provided to give participants a chance to experiment and practice with such skills as summarizing, reflecting, directing, proposing, diagnosing, problem and solution enquiry, and information provision.

Substantial research has isolated the importance of communication skills as essential to effective teamwork. The Conversational Control Model provides a simple and easy-to-use system for aircrew to enhance their skills in this area. It provides a "common language" to facilitate greater understanding and speedier, more effective dialogue.

Team Decision-Making Skills

A further key aspect of the design is the emphasis put on team decision-making. All crews have to reach decisions, often under tight time pressures. Therefore the Aircrew Team Management Workshop includes a number of special group exercises to help crew members develop skills in problem-solving.

Special guidance is provided through team management decision-making models. In the aircrew management workshop we introduce the concept of SADIE. This mnemonic is a shorthand for a set of important problem-solving steps which involve the following activities.

1) Sharing information

2) Analyzing information

3) Developing solutions

4) Implementing decisions

5) Evaluating performance

Through such guiding principles the aircrew members have a basis for practicing teamwork to ensure that information is shared before solutions are developed or action taken. The record shows that aircrew find this system helpful. In particular the fifth element, that of evaluating performance, is now stressed by many participants as a key factor in their own learning on the job.

SECTION D: IMPLEMENTATION AND INSTRUCTION

Line Crew Group Leaders

The management of TAA indicated from the outset that the actual workshop would be tutored by line crew members. Management, check and training airmen were not included as group leaders. Our task as designers was to develop and test the prototype

program and deliver all of the associated educational materials and resources.[5] In addition we also tutored the first live program. From a number of volunteers, ten line-crewmembers were selected to become tutors of the program and in addition there was one member made available by the Flight Standards Division for backup support as and when required.

All of these line crewmembers attended the prototype program and then sat in during the first workshop tutored by the designers. However their task during the first workshop tutored by the designers was not to observe but to practise the management and delivery of the workshop. Because of its participative nature the workshop requires facilitation and consultation skills rather than traditional teaching.

The line crew tutors are therefore called Group Leaders. In all, they had eight ATM-dedicated days intensive preparation inclusive of going through the prototype program. The training involved practical demonstrations and each person had the opportunity to see themselves managing all of the sessions as we recorded their performance on close-circuit television. They were able then to take the videotapes home and restudy their performance. The ATM-related training was followed by a two-day instructional techniques course which included tuition in the use of classroom equipment and training aids.

The ATM workshop is organized so that it can be taught by two Group Leaders working as a regular team. It is estimated therefore that by the time all of the 600 aircrew have participated each of the Group Leaders will have, on average, tutored eight workshops. The results of their performance in this role are impressive. The line crews have high praise for the way in which the Group Leaders undertake their role.

Likewise the Group Leaders have said that the educational design and the materials provided have made it a task well within their grasp. They manage rather than teach. In short, the workshop is an adult-learning activity where people are able to share and compare their experience of team management in the cockpit and the Group Leader's job is to facilitate this.

Pre-Workshop Preparation

A further keypoint of note in implementation is the pre-work which all participants are asked to complete prior to coming on the workshop. As part of our consultation we inquired what aircrew would regard as reasonable given that we felt it essential that people have some understanding and background to the workshop prior to attendance. It was agreed that somewhere between two and five hours preparation would be appropriate. Therefore each person receives a booklet of materials giving an outline of a variety of actual aviation incidents and accidents and other reading material relevant to the workshop.

Learning by Doing

The workshop is designed upon sound educational theory and principles and is best viewed as a structured learning experience. Air crew members have the opportunity to learn through observation, through discussion, through simulated practice, through self-

understanding, through decision-making and other such practical methods. In all the whole workshop is based upon the principles of psycho-educational design which have emerged from many research studies worldwide. In particular we have ensured that many different types of learning experiences are used and have put together a design which minimizes the chance of participants "opting out" or falling asleep! There is a high level of activity with tuition sessions kept to a minimum and learning by doing in role plays, team exercises and group meetings having priority.

SECTION E: EVALUATION AND ASSESSMENT

It has been noted that up to now there is little research evidence to show that programs such as ATM have any marked effect.[6] There may well be an initial positive reaction from the participants, as there has been with the ATM workshop, but the question is, does performance improve? We are therefore actively involved in evaluating and assessing the work that we have done.

In one sense it is difficult, if not impossible, to assess effectiveness in this area. Such workshops on cockpit management are rather like an insurance policy. You will only know when they do not work insofar as there is no decrease in human factors-related incidents and accidents.

Also, ATM is a program of intensive training and development to enhance skills and maintain the already high levels of safety. The question perhaps that one needs to put is what would happen if this form of training is not done. It may well be that incidents and accidents would then increase. In a company such as TAA that has had no accidents in Australia in over 25 years, a measure could be the reduction of simulator recurrent training failures that have been identified as human-factor related. There is an argument therefore to say that this form of training is about maintenance of high standards as well as specific improvements.

Current Assessment of Post-Training Attitudes

However in an airline that already has a high safety record we think it is particularly important to obtain some sort of post-course evaluation so that a measure of the "transfer of learning" can be obtained. One obvious way to do this is to ask participants what they think about the program. This form of subjective measure is regarded by some people as an insufficiently hard measure of performance. However, it does measure attitudes and these do have an effect, in the long-term, over performance.

In the final session of the ATM workshop, participants are asked to complete a short semi-structured questionnaire evaluating the workshop.[7] Responses from the first 97 to have completed the workshop were summated and results for the major questions are provided below.

A major area of importance is, of course, the relevance of workshop concepts, methods and planning tools to the work of aircrew.

Table 1 shows that, on a scale from 1 (irrelevant) to 5 (highly relevant), 100% rated the workshop as a least partly relevant. Such "perceived relevance" is a necessary even though not a "sufficient" factor for transfer of learning back to the workplace[8] and therefore is an essential property of any cockpit training programme.

TABLE 1: RELEVANCE OF THE WORKSHOP

How RELEVANT was the workshop to the work of flight crew?

		%	Cumulative
Irrelevant	(1)	-	-
Little Relevance	(2)	-	-
Partly Relevant	(3)	4	4
Very Relevant	(4)	50	54
Highly Relevant	(5)	46	100

Mean = 4.42; Standard Deviation = 0.57

We also asked participants how useful they found the ATM program. Their responses show a high level of agreement as to its usefulness. Table 2 shows these findings with 93% of participants rating the workshop either as useful, very useful, or highly useful.

TABLE 2: USEFULNESS OF WORKSHOP CONTENT

How USEFUL was the content of the material covered in the program?

		%	Cumulative
Not Useful	(1)	-	-
Partly Useful	(2)	7	7
Useful	(3)	33	40
Very Useful	(4)	51	91
Highly Useful	(5)	8	100

Mean = 3.60; Standard Deviation = 0.75

We also asked a general question on how valuable the ATM Workshop was in particular areas. Table 3 presents data on the value participants attributed to each aspect of the ATM course as they related to their work. This time they were asked to rate each aspect from 1 (Not Important) to 3 (Very Important).

TABLE 3: PARTICIPANT RATINGS OF ASPECTS OF THE ATM WORKSHOP

What was the value to you of attending the workshop?

CATEGORY	Not Important (1)	Important (2)	Very Important (3)	Mean	SD
Self understanding & personal development	5	30	62	2.59	0.59
Developing interpersonal skills	3	34	60	2.59	0.55
Learning new techniques about team management	4	40	56	2.52	0.58
An opportunity to talk meaningfully about my job with colleagues	14	16	25	2.12	0.65
Learning about the managerial non-technical aspects of my work	20	49	28	2.08	0.55
Meeting colleagues I have not met before	24	53	19	1.97	0.70

Of particular interest is that aspects relating to interpersonal skills and personal development were rated most highly. Although the difference is not large, the participants rated these aspects even higher than the team management aspect of the course. Such a finding confirms the validity of a broad behavioral approach to this type of training, incorporating skills and communication training as well as team management concepts.

Finally, participants were asked to indicate whether they found attendance worthwhile. This is an important aspect of any course for aircrew, as such workshops could involve a degree of inconvenience to crew caused by roster-shuffling and the like. Table 4 shows that the great majority of aircrew found the workshop worth attending. More than two-thirds rated the course as either well-worth attending or extremely well-worth attending.

TABLE 4: OVERALL RATING OF THE WORKSHOP

How would you rate the ATM workshop overall?

		%	Cumulative
Not worth attending	(1)	-	-
Attendance of little worth	(2)	4	4
Worth attending	(3)	18	22
Well worth attending	(4)	46	68
Extremely worth attending	(5)	32	100

Mean = 4.06; Standard Deviation = 0.81

Other Areas for Assessment

In addition we are planning a follow-up study, if funds are available and if the airline will support it, to see if there are any observed differences, particularly in teamwork, during simulator sessions. We would like to conduct some "blind trials". One option is to have check-airmen assess the performance of teams in the cockpit without knowing whether or not they have completed the Aircrew Team Management program. Differences in rated performance could then indicate whether there are any changes in performance that could be attributed to ATM training.

In addition to this we are asking for self-report measures based on line operations. We are approaching a number of aircrew members asking them to identify incidents which they feel have been aided by their attendance at the Aircrew Team Management workshop. In addition we are asking the aircrew for an overall assessment of the way in which they see the management of the cockpit during line operations.

As with all such projects it can be said that far more attention needs to be given to assessment. In the reality of the day-to-day world the priorities are getting aircraft out on time, for people to undertake their simulator checks, and for management to keep operations going. Therefore the priority assigned to assessing a program such as this comes second to operational requirements. Therefore, as a general rule it is difficult to persuade the management of any airline to allocate resources to this area. TAA, however, has given their support to three levels of evaluation including the assessment of the participants reactions to the workshop, the post-workshop follow-up and a validity study on the Team Management Index as applied to airmen. TAA has their own plan to assess team management performance in the cockpit through the evaluation of simulator sessions. In the industry as a whole, however, we believe a commitment to evaluation will only come if it is introduced by outside regulatory agencies. It helps to have such backing when requesting funds for support.

Conclusion

Indications show that the Trans Australia Airlines Aircrew Team Management

program has been accepted by line crew as a valid and relevant form of training. The level and quality of the instruction is of a high order. The design of the program facilitates practical skill learning.[9,10] The reported assessments by those attending indicate that it is practical and useful. It remains to be seen whether all of this converts into more effective performance.[11] We believe it does, but time will tell.

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REMEDIAL TRAINING: WILL CRM WORK FOR EVERYONE?

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ABSTRACT

This paper addresses the subject of those pilots who seem unresponsive to CRM training. Attention is directed to the need and opportunity for remedial action. Emphasis is given to the requirement for new perspectives and additional training resources. It is also argued that, contrary to "conventional training wisdom", such individuals do not represent a "hard core" which is beyond assistance.

Some evidence is offered that such a new perspective will lend itself to a wider appreciation of certain specific training needs. The role of appropriately trained specialists is briefly outlined, and a selected bibliography is attached for use by those interested in this area.

This paper is based on the combined experiences of several Pilot Advisory Groups (PAG's) within IFALPA member associations. It does not purport to describe the activities of any one PAG. Some small changes to the text have been made to preserve confidentiality. While much of the activities of PAG's have no relevance to CRM, there are clearly some very important points of intersection. The relevance of these points to diagnostic skills, and remedial training in the general domain of CRM will be obvious to the reader.

INTRODUCTION

It was an honor to receive an invitation from NASA to talk to you today at the Second NASA CRM Workshop. Much of my work for IFALPA involves promoting joint management:pilot action in various areas of operational safety and pilot welfare. The fact that all of us here today share common problems and a joint interest in training and safety issues is a valuable starting point in the search for new perspectives and techniques in CRM training.

My subject is the seemingly "intractable individual"--the pilot who does not respond to CRM training, attempts at remedial training, and/or disciplinary action. Sometimes his enduring problems manifest themselves directly as deficiencies in manipulative skill, notably on check or during transition evaluation, but more often they are associated with difficulties in interpersonal relationships in the cockpit, or an apparent inability to understand the appropriate rules of behavior associated with specific operational tasks, or role activities. Such an individual is, in theory at least, a primary target for CRM training. In practice, he is impervious to its benefits.

Now if one reads the available literature one can find numerous references to the various behavioral characteristics of this kind of pilot. Following, are a few examples to introduce my subject.

The first is from the summary of discussions at the 1975 IATA Technical Conference[1]. There is a reference in paragraph 69 to the problem of "incompatibility between crew members" and the need "to identify the odd-man-out pilot". Attention is also drawn to the fact that the best source of relevant information is the pilot peer group. In paragraph 118 it is noted that expertise is available outside the airline industry to help deal with such problems.

Second is a reference, in the report of the first CRM workshop,[2] to the "many first officers [who] spend a lot of time trying to get out of certain captains' blocks of time".

Also in the same report is a reference to the training consequences of LOFT. This is in the "summary of the workshop" where Dr. Billings refers to the possibility that, "when we've evaluated enough people,...we are going to end up counseling, rather than training or observing". I think that Dr. Billings showed commendable insight and foresight in making this observation, though only time will tell if our shared belief about possible counseling needs is indeed correct.

Crucially, Dr. Billings then went on to make a point which is also central to the case I want to make today: "It is important to recognize the difference between a psychological problem and a proficiency problem because the treatment of the two may be very different". He then points out the need for appropriately informed instructors.

Fourth is the reference by Professor Bob Helmreich in his paper, "What Changes and What Endures"[3], to the limitations of CRM for behavior modification. In that paper he notes the failure of certain resource management courses to change behavior in accordance with management and participant expectations. He also notes the pessimistic conclusion, reached by some specialists, to the effect that, "individuals who represent our mistakes in selection. . .will continue to be problems for organizations throughout their professional careers".

This gives us one side of the problem. There are also financial considerations. Those of you who attended the first CRM workshop may recall the comments by Captains Traub and Crump of United on this subject. They estimated that each mistake in pilot selection cost United $250,000[4] (at 1975 prices) in extra training expenses during the course of a pilot's career. Captain Holdstock of British Airways made the same observation in his presentation, when he estimated the then cost to his airline at very close to the equivalent of $250,000 in pounds per pilot[5]. These are but a few of the available references to my subject matter, though they provide a useful starting point for us.

The basic experience on which my paper is based was gained through the operation of Pilot Advisory Groups (PAG). I don't have time to detail their activities and functioning today, though the following remarks will provide you with essential background information[6].

PAG's of one kind and another operate in about ten pilot associations. Those of you from the United States will probably be familiar with the analogous human intervention and motivation scheme, though this particular employee assistance scheme is exclusively concerned with identification and treatment of pilots afflicted by substance abuse. As you all know, this has been a most successful program, and the very best individual examples are those in which management and pilots cooperate to an optimum degree.

The essence of the PAG concept is peer group identification and monitoring of any personal situation which may have a deleterious effect on the professional performance of a fellow pilot. An advantage of the system is that it allows normal rules of industrial conduct and process to be suspended, so as to allow for treatment and rehabilitation, rather than disciplinary action. Pilots who have a degree of concern about a colleague are obviously a lot happier to bring their concerns to such a neutral body, rather than risk potentially serious consequences if management is informed directly. Obviously, the more serious operational problems generate both peer concern, and a high likelihood of a serious reaction by management.

The essential principles of PAG operation thus involve:

- Management-Peer Group co-operation.
- The constructive and non-threatening use of peer pressure.
- Independence from conventional industrial and disciplinary machinery.
- The use of professional diagnostic and remedial help external to the aviation industry.
- The search for underlying causes of sub-standard performance--in other words, concern is with causes rather than symptoms.

In order to preserve confidentiality the experiences of various PAG's have been amalgamated in my remarks throughout this paper. Before considering some practical examples drawn from PAG experience, let us first look at the traditional responses of management and pilot representatives to CRM problems manifested during pilot training or checking. The conventional administrative and training wisdom would have us accept that:

- The "problem" has been identified by the normal checking system, thus proving the efficacy of that system.
- Suitable retraining has been given. The "intractable" nature of the identified problem is confirmed by failure of retraining.

- Where it is deemed appropriate, additional investigation, for instance medical assessment, is undertaken. Invariably this confirms the absence of an acceptable explanation, or certainly one that is amendable to contemporary training techniques.

- If a pilot continues to manifest deficiencies of skill, role performance, etc., the only remaining policy alternatives are discipline or career termination. These, of course, are the perogative of the employer and frequently trigger defensive tactics by the pilot's representatives.

- It will come as no surprise to a specialist audience such as this to discover that the pilots immediately involved do not often see things this way at all. They deny much of the substance of the case against them. They also harbor considerable feelings of resentment, both at the check failure itself, and at the remedial training provided. A general claim is that the remedial training was, in no proper sense, training.

- Unfortunately this process exacerbates a growing lack of trust in "the system" by the pilots referred to. This is manifested by a perceived sense of injustice, and very often by an unwillingness to face what most impartial observers would see as the "objective reality".

- These circumstances also force both management and pilot representatives to argue along traditional and adversarial lines. And, as all PAG members know, this is a recipe for disaster. For the one thing that traditional lines of argument lead to is a general obfuscation of objective problems.

- The pilot subsequently becomes labeled as intractable, and all parties are locked into the consequent definition of the situation, with all of its adversarial implications.

This is the point at which the story would normally end; a regrettable, but occasional episode in flight operations reaches its inevitable conclusion. Management sees itself as meeting its statutory obligations, and the pilot sees himself as the victim of injustice. So it goes.

There is, however, another way to look at such problems. Central to this perspective is the belief that many of the pilots who find themselves in trouble with their peers or the "check system", are genuinely unaware of their alleged deficiencies. In fact the vast majority of these pilots are never in receipt of a direct and honest assessment of their deficiencies in performance, except possibly in the context of disciplinary action.

Understandably, because their basic problem has not been clearly identified, they are seldom given any specialized training to address specific performance deficits. Now

you may claim that someone with, for instance, a "bad attitude" or "lack of command aptitude" is in no need of specific operational examples of his problem of personality, attitude, or whatever. That, of course, is because the consequences of such deficiencies seem obvious to an observer. But this is, in fact, the crux of the problem: what if pilot concerned does not himself see things this way? The performance problem has not been articulated. Consequently the causal link between low performance and pilot behavior remains elusive. Furthermore, the pilot concerned has not been subject to an honest appraisal of where he stands.

Let us now look at how a behavioral specialist might view this situation. Probably the most revealing and challenging reaction by specialists, to whom such pilots have been referred by pilot advisory groups, is the assertion that we in the aviation industry do a lot less actual training in these problem areas than we may think.

One specialist observed that present training within the aviation industry does not really help these pilots, and while CRM is seen as a significant improvement it simply does not go far enough. For example, one occupational psychologist noted that all of the pilots who had been referred to him had been subject to critical comments and "retraining" by the various airlines concerned. However, at no stage were the precise performance deficiencies of any individual pilot clearly defined. Criticisms tended to be of a most general nature (e.g., "has a bad attitude", or "lacks command aptitude") without any attempt to give specific operational examples or consequences of the declared deficiencies.

In turn, the "remedial training" was never directed at the source of problems. Indeed it has been suggested that the retraining did not, in fact, involve "training" at all, since it only involved simulated flight which repeated normal exercises. At the end of their retraining, pilots invariably got the message that they were in "trouble", but remained ignorant of what that "trouble" was! Here training is equated more to osmosis, rather than to guided skill development in the problem area.

In another case, a small group of pilots did, by their own admission, have long-term problems which were obvious to both peers and the check system. These had never been referred to in training or check records. The fact that manipulative skills were adequate had influenced records until a point of crisis brought problems of cockpit role performance to a head.

The existence of a clinical case of "testitus"[7] was identified in another case. Here harsh handling set up a vicious circle of check failure and a lack of trust. Ultimately this resulted in the voluntary departure of the pilot from the airline concerned. After a specialized program of relaxation techniques and specific guidance on certain cockpit role activities, he made successful progress in his new airline. Here the real "training" took place outside of the aviation industry, although it involved a sympathetic simulator instructor at the later stages.

It was also noted that several pilots referred by their PAG had been involved in significant "life event" changes just prior to their reported difficulties. One specialist suggested that such events were enough to have a serious effect on all aspects of these pilots' CRM performance. He felt that both social and cognitive skills deteriorated in the

cockpit environment, since none of the pilots concerned had sufficient spare resources to cope with the additional life stresses to which they were subject.

It is interesting that most of these pilots were drawn to the attention of the PAG both as a result of serious personality clashes, and reports of operational problems associated with particularly bad decision-making. Removal of, or accommodation with, the life stressor permitted a safe return to flying status, though specialist assistance and guidance was also necessary.

The hypothesis is offered that in different circumstances these pilots, who are now functioning in a fully acceptable fashion, might simply have been seen as having become permanently below standard. The kind of rationalization frequently used in such cases includes the idea that the pilot was, "always was a bit weak" or "is getting a bit old now". Such statements are often used to rationalize and justify marginal performance and its attendant consequences. They also imply that such marginal performance is beyond redress.

There are many different information sources for PAG's, with each report being assessed using normal PAG criteria. Sources can include peer reports, air safety reports, management reports, check airmen reports, and internal or restricted confidential reporting systems. In addition, there has been limited use of PAG follow-up in cases where a pilot has been involved in an unanticipated or dramatic check failure. Here the seriousness of the failure is itself seen as a problem needing investigation and explanation. Interestingly, there also have been a series of self-referrals by a few pilots who sense the existence of problems with which they need help. This is notable, in that self-referral in most other areas of PAG operation is very rare indeed. Trust and confidentiality are obviously essential to achieve this desirable state of affairs.

One PAG member also observed to me that it is the crew schedulers who really know who are the real "problem" pilots; in his words, "they see who are the bid-around individuals". Obviously this observation only applied to those airlines which use a line-bid system.

In addition problems deriving from personality clashes, seriously inadequate in-flight decisions or crew dynamics, are sometimes reported only verbally to a pilot association, due to apprehension about the consequences of more formal action.

Given information from these sources what does a PAG do when it determines that action is necessary? One PAG simply uses a variation on "normal" intervention techniques; they bluntly put it to the pilot concerned that:

> "Your peers think that you are absolutely rude to work with, and the situation now has reached the point where we feel it appropriate and necessary to take action. You must see one of our PAG specialists and then undertake a personal evaluation of where you stand in relation to your career."

In these cases the decision to take action is necessitated by established procedures in which reports are assessed on the basis of how cockpit conflict affects safety. This tends to mean that intervention takes place only when events have reached a fairly serious

stage.

One PAG attempts to achieve early intervention and provide long-term remedial help. This is in recognition of the fact that remedial action may need to extend over a relatively long period if permanent improvement is to be achieved. The reports from this PAG confirm that the pilots concerned deny or rationalize their problems if they are treated in the conventional industrial manner. On the other hand, sympathetic and careful handling will elicit a different response, and the pilots will often concede that there is indeed something wrong, but they are unable to understand what it is, and thus to take suitable action themselves. Priority is placed in this PAG on the willing and active volunteer.

The majority of the pilots referred to are adamant that the formal airline training system has been of no assistance or guidance. Undoubtedly a contributory causal factor here is the primacy currently accorded to manipulative skills. In any case, these pilots tend to have a strong sense of distrust and injustice. This is one reason why such problems are partially hidden from view. If the pilots concerned do not trust "the system" or feel there is no safe avenue for help, it makes formal detection and remedial action that much more difficult. Not least of the difficulties is the defensive, inward-looking and uncommunicative stance of many of the pilots concerned.

It should be clear from my comments that a new approach and new training methodologies or techniques can be of real benefit to many pilots who prove unresponsive to CRM and other training. The fact that our present methods do not meet the needs of all pilots, or those of the total aviation system, is clearly no guarantee that additional techniques are not in fact available.

When dealing with pilots who are unresponsive to CRM training, we are in need of new methods of optimizing our human resources. In particular, we need new methods of identifying performance deficits with precision, and optimizing the developmental aspects of available training techniques. We must also re-examine our methods of performance appraisal. Furthermore we need to find a non-threating method of bringing relevant information to these pilots. Methods which are perceived as threatening are never effective. Neither are they likely to reduce the associated human, economic and industrial costs to our industry.

In particular we must differentiate between the evaluative or checking elements of assessment, and the developmental or training elements of assessment. These are different processes, and they have markedly different implications for improving interpersonal relations and pilot performance. While evaluation and examination are important to the aviation industry, it is essential that they are kept clear of that remedial training which deals with the sensitive aspects of problems presently under discussion. Not least of the reasons for this are the risk of premature career termination, where everyone is a loser. There is also the central issue of each pilot's self-esteem; a man facing the psychological and industrial "unknown" needs, above all things, to feel secure. I think that you will agree that such personal and emotional security is manifestly essential to effective remedial training.

We must also recognize that pilot manipulative skills are different from management

skills, which are different from CRM skills, which are different in turn from the particular skills needed to assume command. Only a clear recognition of different skill requirements and their behavioral characteristics will allow us to specify deficiencies and provide appropriate training.

In addition any system of performance appraisal and personal development must have clear goals and a commonly agreed baseline. Interpersonal performance can only be improved effectively through a system which involves self-learning and internalization. Clearly the emphasis must always be on future performance and not on past failure.

Two things are becoming clear; the desirability of peer involvement, and the necessity of a more sympathetic and sophisticated insight into the difficulties faced by these pilots. The PAG concept has been effective in early attempts to help such pilots. It allows the normal rules of industrial behavior to be suspended, provides essential guarantees to the pilots involved, and encourages the willing and psychologically honest involvement of the pilots in new training methodologies. It should be clear, however, that a much greater effort is needed in the future to analyze and solve the outstanding puzzles.

I will now direct my remarks to training methodologies used to date. The first task undertaken by one specialist was to identify precise pilot performance, or "pilot behavior", which reflects the generalized complaints which had been made.

He then establishes a baseline for the behavior in question. This helps with measurement of the effectiveness of remedial action. Rating scales are determined in relation to the specific problematic behaviors. Existing documentation from NASA, the FAA, Transport Canada and the Institute of Aviation Medicine, Farnborough, as well as peer reports and self-appraisal have all been used to develop rating scales. Provision is then made for peer- and self-rating using these scales. The general categories addressed to date include command management, social and communication skills, problem-solving and decision-making, task orientation and attention.

In addition, use has been made of a battery of personality tests, of which the 16 PF questionnaire is found to be of value. Specific personality strengths and weaknesses are thus identified and discussed with the pilots in relation to their reported performance.

Skills training and behavioral measurement based on these tests have also been developed. They provide a means of tackling performance deficits which can be objectively observed in the actual flying environment. Remedial training methods include simulation, discussion, use of the repertory grid, and supervised simulator and line flight.

It is anticipated that some time will be needed to achieve long-term change and thus to reach, and report, definite conclusions about the efficacy of these particular training methodologies. However, I can report that pilots involved in such training exercises are extremely happy to find themselves involved in schemes which are tailored to their needs. They certainly feel that somebody is sufficiently interested in their perspective to make the effort worthwhile. Pilots and specialists are convinced that progress is being made, though only time will tell if their considerable optimism is justified.

Before concluding, I would like to make a few observations on the medical and psychological nature of the problems under discussion. One specialist who reviewed an early draft of this paper suggested that I made the pilots concerned sound as though they were all suffering from some kind of "intractable" disease. He pointed out that they certainly did not have a disease of any kind, and suggested that the implied medical analogy was singularly inappropriate. In this reaction he was echoing sentiments expressed by Dr. Stephen Sloan at a recent ICAO Aviation Medicine Seminar[8].

Dr. Sloan suggested that the tendency within aviation medicine is to concentrate on those pilots whose symptomology necessitates medical intervention. These pilots are correctly identified as being "sick". They may be considered analogous to those pilots whose manipulative or role skills have fallen markedly below a satisfactory check standard. Dr. Sloan suggests that this very small number of pilots, at the extreme of the normal distribution, are not, in his words, "the really interesting group". The group of significance and importance to operational safety, are those immediately below the extreme limits of the normal distribution. They cannot be labeled as sick, psychologically incapacitated, or below acceptable skill standards. But their performance is, to a greater or lesser degree, adversely affected by psycho-social stresses or personality factors. They also tend to exhibit CRM performance deficits which may not be responsive to current CRM training.

It has been observed that pilots are more than willing to talk about stress, though precisely what they mean by stress can be hard to identify. However, it must surely be obvious that stress, whatever it may be, is an eternal part of both the flying business and life itself. We tend to associate serious stress problems with the notion of a precipitating traumatic event, such as an accident. Perhaps we would do better to also consider the slow erosion of motivation and psychic defenses over time. The consequences of this have considerable implications for CRM performance. Important also is the probability that any pilot whose social skills have been affected by stress will be unable to respond adequately to conventional CRM training techniques. Or they may appear to do well in ground-based CRM training, while being unable to transfer it to the aircraft.

It is, however, a fact that the vast majority of the "literature" relating to this subject is medically-oriented. As we make a greater effort to look to the psychology of pilot CRM performance, I suspect that we will do best to keep the medical findings in mind, but to use the tools and techniques of the psychologist.

In particular, we must be very skeptical of how we assess the training/CRM problems manifested by a particular pilot. What is seen in the simulator or while airborne might appear obvious, but all may not be as it appears. For instance, why does a perfectly reasonable captain outside of the cockpit, become a tyrant when he goes flying? Or, why does a highly-regarded pilot at the time of employment become an inconsistent and truculent captain later in his career? If we truly understood why these things occurred we would be able to prevent such problems, or more likely, help affected pilots return to a harmonious and safe working relationship with their colleagues.

Such pilots may well manifest problems which should have been evident at the time of selection. Equally they might manifest the results of many years of exposure to stress.

In fact, I believe that the effects of perceived stress over long periods of time will eventually prove to be as much of a problem as personality attributes identifiable at the time of initial selection[9]. However, it remains a simple matter of fact that no one knows to what extent problems, present at the time of initial selection, are confounded with problems that are of more recent origin.

And finally, when discussing CRM and the precise manifestations of problems in the operational environment we must also bear in mind the influence of sociological factors. These often ensure that the particular forms of crew dysfunction in one country do not always appear in another. Indeed within any given country airlines themselves can differ quite markedly in terms of their corporate and operational culture. This too can profoundly influence the practical manifestation of some of the problems discussed earlier.

This paper has been necessarily discursive and allusive as to the nature of "enduring problems", and potential training solutions. This has been an intentional strategy, for the problem as much as the solution, is not adequately documented. But that there is a problem, or far more likely a confusion of several different problems, can hardly be denied.

I hope that one thing at least can be agreed: the failure of any CRM program to change pilot performance should not preclude a search for greater insight, and new remedial training techniques. Failure to respond to CRM training need not of itself be a precursor of career termination. Nor should it preclude the search for other causes of low pilot performance. Certainly everyone is a loser when a productive career is prematurely terminated. Our task in the future must be to jointly and continually seek innovative solutions to these problems, and thus promote the objectives of training efficiency, high operational standards, pilot well-being, and aviation safety.

I would like to end with an entirely fictional story about one of your colleagues. See if you can recognize anyone you once knew. He joined the airline many years ago, about the same time as you did. He was a fine pilot and the most sociable of colleagues, but he is no longer sociable. Neither is he now considered a fine pilot. Actually he is a pain for his co-pilots to fly with, as you recently discovered to your surprise. And over a few drinks co-pilots tell you strange and often inconsistent things about your colleague. Some of them actually think he is not all that safe a pilot, especially under pressure. He seems to undergo a complete personality change when he enters the cockpit. In fact he has changed totally over all those years. Why? And what can I do to help?

Can I suggest to you that the only remarkable elements to this story are the last two questions? By this I mean that you do indeed have such colleagues, but like most of us, you did not recognize the gradual change over time, or you rationalized it away. And we almost never ask "why?" But the central issue must be, "why?" Why has it turned out this way? For myself, I think that this is almost the best question. Actually it is the second best question, for the best question of all is, "What do I need to understand to be able to help?"

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COCKPIT RESOURCE MANAGEMENT TRAINING*

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1. The 6th General Flight Crew Training Meeting held in Montreal in May, 1984 was for most IATA member airlines the first time they had been exposed to what was then a relatively new aspect of flight crew training--resource management training. Present at that meeting were 164 representatives of 70 different airlines. The report of the meeting stated in part:

   "A number of factors bearing on pilot acceptance of the training were discussed. Some airlines had considered national or ethnic characteristics in designing their programs. Some had found a greater level of acceptance and enthusiasm among their younger pilots, but in that connection opportunities for role reversal, both in the aircraft and in LOFT exercises, had often proved a more significant factor. Other airlines confirmed the overall results given in the United Airlines' presentation.

   "There was no apparent consensus on whether resource management training should be offered as a stand-alone program or as an integrated part of a total aircraft training package. Both options had been employed successfully. In each case, however, there was agreement on the need for recurrent training, and for giving trainees a sound conceptual framework for the skills they were expected to practice. Integration of the training into the total aircraft package appeared to most directly address earlier concerns regarding its possible requirement by regulatory authorities, and also possible management insistence on cost effectiveness justification for "new" programs.

   "From floor indications relatively few of the airlines represented had so far implemented resource management training programs. It was hoped that this agenda item had both stimulated others to do so, and had provided some useful guidelines."

2. In reviewing the results of this meeting the IATA Flight Crew Training Sub-Committee (FCTSC), which had been responsible for the agenda and the meeting itself, concluded that because very few airlines had implemented a program or even appeared to understand the term "resource management", a member airline survey should be conducted and the results analyzed. This presentation shows the results of that survey in a form which can be related to the topics of this workshop.

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*The views presented are those of the author and may not represent the views of IATA.

3. Twenty-four airlines or 17% of the membership of 140 airlines responded to the survey which was completed in December, 1985 and presented to the IATA FCTSC in April, 1986.

4. Geographically, the twenty-four airlines came from the following areas:

Europe	8 Airlines
Americas	7 Airlines
Far East	6 Airlines
Middle East	2 Airlines
Africa	1 Airline

5. The survey consisted of 8 questions. The first of these asked whether or not a RMT course had been implemented or was one planned.

- 14 airlines confirmed a course had been implemented.
- 6 airlines planned to introduce the training.
- 4 airlines had no plans, 3 were investigating the possibility.

6. The next two questions, which can be related to Topic 1 of this workshop asked for a definition of the the program and its goals and requested the syllabus. A typical response to the definition request was "to reinforce the qualities of effective and efficient leadership". Leadership was mentioned in 9 of the responses to this question.

7. With regard to the syllabus the responses were indeed varied with 20 different responses. A typical content would be*:

- Information Processing
- Decision-Making (9)
- Human Factors
- Automation
- Pilot Error
- Safety Record
- Leadership (6)
- Industrial Management
- Command
- Crew Cooperation (6)
- Communication (10)
- LOFT

*The numerals in parentheses indicate the number mentioning this subject.

8. With respect to Topic 2 of the workshop the IATA survey asked two related questions: "To whom was the RMT course given?" and "In what manner?"

9. Four airlines gave the course to captains only and 7 airlines to all flight crew members including management pilots. The other responses varied.

10. The method(s) reported used in the courses were as follows:

- LOFT	2
- seminar/workshop	5
- lecture	8
- home study	2
- audio visuals	1
- flight simulator	4

11. The next two questions asked in the IATA survey were "How long was the course?", and "How often was RMT training given?" These questions relate to Topic 3 of the workshop.

12. Of the airlines responding, the longest course was 16 days and the shortest 3 hours. With regard to the frequency of training this varied from once only to 3-5 days each year.

13. The final question we asked was for the airline to quantify the results of their program and this question relates to Topic 4 of the workshop. The answers again varied and this of course was not unexpected. Examples were:

- impossible to postulate
- too early to evaluate
- better safety record
- most satisfactory

14. In summary I feel the survey has revealed the diversity of opinion that was prevalent at the time the survey was conducted. The reason for this may well be that cockpit resource management needs to be tailored to the person, the airline, and the type of operation conducted. Certainly, based on these result, I am convinced it is not time for regulations requiring CRM training. More than one good concept has been ruined by the regulators acting in haste. It is my hope that this NASA/MAC Workshop will help us reach a conclusion as to an optimum way to train for safety through resource management training.

GENERAL DISCUSSION

DR. FOUSHEE: We have scheduled this final period of the day for general discussion and questions and answers regarding today's presentations. All of the day's speakers are here, so could we have questions from the floor?

COL. NELSON: I would like to ask Capt. Yamamori to elaborate on his experiences with cultural differences in the CRM program, and explain some of those differences between American and Japanese pilots. Secondly, have you been able to identify any results from your program, and could you mention some of them?

CAPT. YAMAMORI: We have not done any systematic profiles, and we are in the early phases of implementation.

COL. NELSON: What about the future? Are you trying to measure those differences?

CAPT. YAMAMORI: I don't think I'm experienced enough to give you an answer.

DR. FOUSHEE: I think Ed Carroll may be able to clarify.

CAPT. CARROLL: Perhaps there is a bit of misconception. It was suggested that JAL had trained 2300 pilots at this point, but that's how many they have to train. They just started the program this past month and have now trained 60 people. Capt. Yamamori says he has not established a data base with which to measure the impact, not only because of the small numbers, but because we are unsure how to evaluate it.

DR. FOUSHEE: Bob (Helmreich) or Richard (Hackman), do you have a comment on the evaluation issue?

PROF. HELMREICH: It would be fascinating if you could establish a data base and attempt to look at some of the cultural differences in this area. I suspect there are some. I would also like to parallel what Richard (Hackman) said this morning. I suspect that some of the cultural differences we suspect may be present are very similar (in scope) to some of the organizational differences we have between U.S. carriers. Even organizations in the same countries, often have their own different types of cultures.

CAPT. CARROLL: My frustration is rampant. It is hard to cover so much material in a short period of time. One of the things we were unable to cover this morning is a discussion of some of the evaluation issues. One of the things we do in our CRM training is to establish a data base of individual's self-perceptions before they undergo training, and we look at these perceptions. When people start out in the training, they have an image of themselves as doing things in a certain way, and they usually feel they are doing a pretty good job. When they finish the training, they tend to perceive that their way of operating was perhaps not as good as they thought it was initially. We evaluate the percentage of change in these perceptions. There is about a 60% change--they look at themselves and say, "I'm not quite as good as I thought I was in the cockpit."

When they ran the seminar in Japan, I was there, and Capt. Yamamori administered the seminar. They did the same thing with their people, with the same material, and asked the same questions. Interestingly, their initial perceptions of optimum performance were not as high as the American statistics would indicate. Our perception is that 80 to 82% of the time, we operate in an optimum fashion, but they start off with 47% of the time. I was scared to death when I saw those numbers, but they explained to me that their culture is such that they are not viewing their own individual performances as optimum, but tend to view performance from the group standpoint. So they were starting from a different frame of reference. Interestingly, however, is the percent change between initial and post-training assessments. What we saw was the same percentage drop or recognition. Ours is about a 60% drop and theirs is about a 50% drop. From a training effectiveness standpoint, we're seeing similar things even though, the two cultures are starting from different levels.

One gratuitous comment to Jim Davidson (TAA)--why don't you use our program, there sure are a number of similarities.

CAPT. HENRY: I have a question for Dr. Helmreich regarding your discussion on whether CRM training should be focusing on personalities or upon attitudes, and your suggestion that we should be focusing primarily upon attitudes because they are more changeable. I wondered whether any work has been done focusing on personality types and crew performance for scheduling purposes, so that the strengths of one may complement the weaknesses of others?

PROF. HELMREICH: Essentially zero, because it is difficult to find a situation where you can go back and look retrospectively at personality in terms of scheduling. Somebody mentioned that most schedulers already think that there are 27 too many variables in the scheduling equation already, so they would probably hit you with a 2 x 4 for asking that question. On the other hand, there are some fascinating simulator studies of crew performance in areas that Clay Foushee is working in, and maybe he has something to say on the issue.

DR. FOUSHEE: It is very difficult to do the types of studies your question referred to in a controlled, experimental fashion, so we can't shed any light on your question at present. On the other hand, those types of questions do figure very prominently in our future research plans. NASA is very interested in crew selection and pairing for isolated environments like the space station, and personality is one of the areas we will be looking at very closely.

CAPT. DAVIDSON: I would like to respond to Ed Carroll's comment. The similarity of the two programs extends only to some of the concepts, but our program was developed based on a lot of observational work in our company. Maybe Charles (Margerison) can elaborate.

DR. MARGERISON: We spent a year working with TAA, flying in the cockpits, talking to crews, union people, etc. We worked very hard to develop a program suited to their needs, and we are very proud of it. It has been developed based on a lot of fundamental research that we put in to it, and I would be happy so share the details with anyone who would like to talk about it.

DR. FOUSHEE: If I may interject something here, one of the purposes of this workshop is to take a very critical look at CRM training as it is presently being practiced in the air transport world. I must say at this point that one of the fundamental questions is whether there are many different ways to undertake training in this area, or whether there are a few fundamental concepts that must be addressed in any CRM training program. If the latter is true, it would not be very surprising to see that programs developed independently seem to be very similar in many respects. Moreover, it will probably be impossible to determine what specific concepts were invented where, and it is probably not important.

CAPT. McINTYRE: I would like to address the question of personality matching to optimize the crew process. To me this is the antithesis of what CRM is all about. CRM is about taking disparate personalities or resources and managing them in the best possible fashion. If we start getting into the game of matching personalities, we're going to create a world we cannot live with. It is not the case on most airlines that copilots can bid out of certain captain's trips. It is done privately sometimes, but that is not a resource at his disposal.

DR. FOUSHEE: That is an important point, Jim. It would indeed be very difficult to imagine a scheduling procedure, whereby compatible personalities are matched. However, it may be possible to screen in desirable characteristics in the selection process, and that may be the most appropriate way to think about using personality criteria. More questions?

COL. BIANCUR: I have a question for Prof. Helmreich and Prof. Hackman. This morning, as you developed your ideas, both of you tended to focus upon the individual first and foremost. Prof. Hackman, even when you were talking about groups, you addressed the individual. That presents something of a problem for me, because even though each individual in the crew has an individual identity, as the crew comes together, their personality traits all merge to develop something that becomes a crew trait. It appears to be something quite distinct from the particular traits of individuals. We see this phenomenon in MAC quite often, where different organizations exhibit completely different characteristics and individuals take on the characteristics of their units. You can easily recognize it, whether you are on the ground or in the air. You can say this person comes from Unit A and that person from Unit B just by the way they conduct themselves. I would suggest that somewhere in the research in this area, we have got to begin to look at the crew as an entity rather than a collection of individual characteristics.

DR. FOUSHEE: Bob (Helmreich), would you like to respond to that, and then Richard and I might have something to say.

PROF. HELMREICH: I'm delighted to hear you ask that question, because it suggests to me that he may be farther along than we are. I think our discussion reflected the fact that we are so caught in the individual mold, but certainly one of the points both of us were trying to make is that we must do a better job of looking at the crew as a unit of analysis. However, it is important to note that to some extent you always have to work at the individual level. For example, in selection we are seeking to pick qualified individuals, and if we do a good job in this area, theoretically the crew process will

improve. I don't think you can grab anybody from anywhere and make them effective crewmembers. We have to evaluate individuals before we can evaluate crews.

COL. BIANCUR: That is very difficult for us, because we must retain schedule flexibility. We have got to be able to pool the people who are available, whatever they are doing, make them a crew, and put them on the road for 15-20 days, and have them operate as effectively as any selected crew.

PROF. HELMREICH: I think we are talking about different things. I am talking about how you go about selecting people into the pool from which you should then be able to draw anyone randomly. Once you have done that, we are talking about the same thing. I don't think you are suggesting that we can take any living human being and make them pilots. I am saying we can select individuals with the appropriate characteristics, personality or whatever, and then you should be able to compose a crew without any difficulty. I don't think there is any disagreement with regard to technical aptitude, but we don't have guidelines with respect to characteristics governing interpersonal behavior, hence crew interaction and performance. One of the ways we could learn about these factors is to do research that determines what types of personalities work most effectively with others. We are, in fact, talking about training approaches to effective crew performance, but I think selection is another way of attacking the problem.

PROF. HACKMAN: There is this blackboard (used in Hackman's presentation) in the corner over there which has the word "shell" in one corner of it. What I was trying to suggest was that in a performing unit, such as a transport crew or whatever, if you do a good job of building up that shell, you will develop expectations and knowledge about how one is supposed to work within it. This is particularly important when you have two hours to get a group of people together to start working. If you have done a good job, you are far ahead of the game because you have a group of people that share a common understanding about how we operate here (within the shell). This yields the kind of flexibility that you need, not only in the military, but in the civilian population as well. Part of the thrust is getting that collective understanding of how we operate here, so that the captain can build a fine group with the headstart the shell provides. It then goes beyond that. There have been two or three veiled references today about the crew familiarity study, and I wonder if we might hear a little more about it from Clay (Foushee).

DR. FOUSHEE: Alright, there isn't a lot of time, but I will briefly describe what we did and what we found in that study, as John (Lauber) mentioned it this morning. The study was actually part of a congressionally-mandated study of the effects of flight crew fatigue. Because there is very little solid research on the operational significance of this variable, we designed a very high-fidelity full-mission simulation experiment where fully-qualified crews flew the simulation before or after a high-density, short-haul duty cycle. Half of the crews flew it within 2-3 hours after completing a 3-day cycle which averaged around 8 takeoffs and landing per day, with at least one day, usually the last, averaging 13-hours on duty. Actually the last day was closer to 16 hours in many cases due to the length of the simulation. The other half of the crews flew the simulation after a minimum of two and usually three days off duty.

We looked at the fatigue factor and found, not surprisingly, crews in the "post-duty"

condition were significantly more tired than were the crews in the "pre-duty" condition. But, since we were primarily concerned with whether these fatigue levels affected performance, we looked at crew performance in these simulated flights extensively. We measured crew performance in several different ways, and I'll just touch on them briefly. First, we had a specially-trained check airman observe all the flights to evaluate performance on standardized dimensions we had designed for this particular scenario. Second, we looked at aircraft handling data that we took from the simulator computer. We also did a considerable amount of work with error analyses from two independent sources so that we would have complete confidence that the data were not biased. All simulations were videotaped and extensively reviewed by independent observers.

Now this is going to be terribly oversimplified, but what we found was a fascinating pattern of results that overwhelmingly indicated that the "tired" crews were performing better than the "rested" ones. Moreover, this was true across the board on all indications of crew performance--errors, systematic ratings, and aircraft handling data. While there were dimensions on which we saw no significant differences, there were no cases where the pattern was reversed--that is rested crews performing better than tired crews.

To some this pattern may seem at little paradoxical, it was to us at first, but there is an important difference between crews at the beginning of a trip and crews at the end of a trip in addition to the fatigue factor. At the end of a trip, obviously crews are considerably more familiar with each other than at the beginning, so we conducted some different analyses to try to account for that factor. Some of the crews were composed from individuals who had flown the same types of duty cycles, but not together. Other crews were composed of individuals who had flown their last trip together, but had been off duty for the past three days. We then reanalyzed all of the data based on who had flown together versus who had not on the last duty cycle, and what we found was very interesting. All of the differences were stronger, which suggests that it was the familiarity factor that accounted for the crew performance differences.

As we have been discussing most of today, there are a number of subtle interpersonal phenomena that affect crew performance. So even though all crew members are equipped with the same standard operating procedures and the like, there are measurable and robust performance differences due to these variables.

CAPT. TESMER: Were the crews two- or three-person crews?

DR. FOUSHEE: Two-person crews.

MR. HUNTINGTON: As I listened to some of the various questions being raised, and in my exposure to various airlines [portions inaudible], one of my concerns is what are the most appropriate cockpit styles? One of the things we need, but don't have is the definition of what makes a crew. We can talk theoretically and we know what looks better, but can we define what appropriate crew responses are? If we can't provide that kind of information in training, I'm not sure we'll get the kind of behavior we're looking for.

DR. FOUSHEE: Any other questions or comments? It's very late, and I think we have

probably overloaded everyone, including myself. We have had a wealth of information presented today, and I would like to thank all of our speakers for the hard work they so obviously put into these presentations. We have many more scheduled for tomorrow, so let's adjourn and reconvene at 8:00 in the morning. Thank you.

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INTRODUCTION TO MAC CRM TRAINING

Major General Donald D. Brown
Commander-in-Chief, 22nd Air Force

I think perhaps I first ought to talk a little bit about MAC for some of our symposium members who may not have recognized that we are not merely the transport part of the United States Air Force. Too frequently that is what we are known for, although admittedly, that is probably 75 percent of our business.

Ed mentioned the fleet size, and we do have some 70-plus C-5's and 244 141's and about 330 active duty C-130's and a like number of reserve 130's, so the total force of MAC is probably somewhere around 1400 aircraft. We also operate 80 Lear Jets and forty Beech turbo-props. That is a different kind of environment. Some of you here are in the executive business and appreciate that. But we also have some airplanes called MC-130's that do some things in rather strange operating environments, like very low level, very late at night, without lights. We have a fleet of AC-130 gunships. And when all that murder and mayhem is dispensed with, we've got our fleet of C-9 aeromedical evacuation aircraft. We also have almost 200 helicopters. Another different operating environment from those of you in the airline industry.

I think our most demanding missions are those flown by crews who take a C-130 into a 3500-foot iced-over dirt strip in Alaska which has a one-way approach to it, where you're committed to landing at the mile-and-a-half-out point. There is no go-around because the hills are too high. Or perhaps the 141 that flies at 300 feet, 250 knots, blacked out, with the crew operating on night-vision goggles. Those are just a little more constraining than San Francisco to Washington, or Tokyo to Seattle. And obviously, in that kind of an environment, crew coordination and cockpit management become extremely significant to us.

Our crew resources range from some 15,000-hour pilots to brand-new ones out of undergraduate training who come to us with 265 hours flying time and have never been in an airplane with more than two seats, one of which is an instructor's.

Cockpit resource management is nothing new to the Command. We have called it other names. My first exposure to it was as a co-pilot training in a C-118 or DC-6 in 1956. I was taught that I had certain duties to perform as a co-pilot: advise the pilot of radio settings and altimeters and clearances, monitoring aircraft systems performance and monitoring the behavior of all crew members to ensure consistency of performance. I was the checklist-runner at that time, and all of your co-pilots do those same kinds of things.

CRM under another name was reinforced in '59 when I went through the formal instructor upgrade training conducted by a doctor of education--one Gale Miller, who is still with us. This was a formal school that discussed interpersonal behavior, evaluation techniques, communication, and seminar leadership.

In the early sixties, I served a tour as an instructor in that school and I taught a course they called "pilot judgment." It was much like a program described for us yesterday. We reviewed all the previous accidents of the two to three years prior and assessed the performance of crew members in each of those accidents. What should the co-pilot have done differently? Did the engineer advise the aircraft commander properly? Did the aircraft commander utilize all the data available to him? We would say today: Did he use all his resources? What was his leadership, or lack thereof?

I left the command for a while, came back after five years and found myself involved in five-day annual simulator refresher programs, again similar to some described yesterday. Included were aircraft performance, systems training, air crew coordination--albeit without the video cameras--and line-oriented flight training that included one full period of four hours. This was particularly significant to us in those days of flying the Berlin corridor in the electronically-hostile environment with jamming and voice intrusion, false navigational aids, et cetera.

Currently, our initial training stresses those same basic things--performance, systems and crew coordination if you're the copilot or the flight engineer; leadership, if you're the aircraft commander. Our line refresher training today is programmed so that systems operations are reviewed in cockpit procedures trainers, and our simulators are used for LOFT missions over representative mission segments built by each individual wing for the route structure they most frequently fly.

Now, why then, if we have been smelling this rose by some other name, were we so concerned that in the period from 1980 to 1982, would we ask a panel of recognized authorities in the field of aviation education (operating under the purview of the Air Force Scientific Advisory Board) to review all of our training practices? Why then, if we are so good at this and have been doing it for 30 years, are we so interested in having NASA/Ames chair a symposium with us on the subject of cockpit resource management? Very frankly, we did it because we found in the late seventies we had "backslud," as Dizzy Dean might have said.

We found in the eighties that while we thought we had a forward-looking philosophy in the command, we had been very retarded in the use of the technology of education.

Now to draw upon the theories of training presented yesterday, we are certainly interested in ensuring that our instructors are properly selected. They must have enough flying experience and a level of qualification that they can teach flying skills and certainly must establish their credibility with the crew force that they're teaching. And we recognize they must also be capable of training the skills of problem solving and communication and motivation and in small-group behavior.

We think that our "pre-existing shell" is conducive to an aircraft commander establishing himself as an effective team leader. But we also recognize that the world of reality causes us to put otherwise perfect strangers together to form a crew. We are concerned that all members of that crew form a cohesive, cooperative unit early in their acquaintance, hopefully before they ever climb aboard the air machine.

We find each day as we form crews that we have a few old heads who are very skeptical and we have some of those newcomers who have never flown a "crewed" aircraft. And we also find a few "backsliding sinners." We find ourselves with some staffers who are a little reluctant to turn course developments over to line units, and I have to admit we have a few skeptical wing and squadron commanders.

We have only within this last five or six years come to full recognition of the value of computer-assisted course development, of the value in developing crew coordination and of role playing. And certainly we have not really taken advantage of video capability to record performance so that crew members can, in fact, go through self-assessment. Therefore, we have asked these people to help us.

We sought the assistance of commercial aircrew training organizations. In our first presentation today, we will discuss the application of the United Program to military operations. We have encouraged development of cockpit resource management for initial and continuation training, for reinforcement at each of our individual wings and squadrons. In our other presentations, we will talk about the approach taken by our helicopter and rescue 130th Training Wing and of the approach of one of our airlift squadrons, which happens to be a reserve squadron.

We sought through this symposium to learn from you, to help synthesize our thinking, to review your approaches and to participate in the workshop's exchange of ideas. We think our program is ongoing, but for us to stand here and say that we have a great cockpit resource management training program and it's working magnificently would be sticking our head in the proverbial sand. So we are participating in this program.

We are going to hear first from United Airlines and Seville--Captain Dale Cavanagh and Dr. Williams. And then we will turn to Lt. Colonel Biegalski and Major Halliday from up at Travis--my 349th Wing up there. We will talk about our squadron applications. I hope you will see how we have chosen to apply this training at different levels of our organization and how it has worked for us.

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THE APPLICATION OF CRM TO MILITARY OPERATIONS

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INTRODUCTION

CAPT. CAVANAGH: Cockpit Resource Management (CRM) training, as we think of it today, had its origins in the NASA-sponsored industry conference held in 1979. Many of the concepts advanced during that conference were followed in the development of United Airlines' Command/Leadership/Resource Management training, the first large-scale industry effort. The favorable response to the United Airlines' training and related programs led the Air Force to require that CRM be included in the contractor-operated C-5 Aircrew Training System (ATS), for which United Airlines Services Corporation (formerly Aircrew Training) is the prime contractor.

The detailed content of the CRM training component of the C-5 ATS was left to the discretion of the contractor. As a part of determining what the content should be, United Airlines Services Corporation has made an effort to understand how the needs of MAC crews compare with those of civilian airline crews.

There are distinct similarities between the crew roles in the cockpits of civilian airliners and military air transports. Many of the attitudes and behaviors exhibited by civil and military crew members are comparable, hence much of the training in the field referred to as Cockpit Resource Management is equally appropriate to civil or military aircrews. At the same time, there are significant differences which require assessment to determine if modifications to what might be termed "generic CRM" are necessary.

Our investigation has enabled us to define and specify CRM training which we believe addresses the needs of the C-5 operational community. The study has concentrated largely on military airlift, but we believe the training objectives and course content of our CRM training are readily adaptable to a wider range of military cockpits than are found in strategic airlift. For instance, CRM training focusing on communication, leadership, situational awareness, and crew coordination is just as appropriate, with some modification, to the pilots manning a flight of Tactical Airlift Command A-7's as it is to the pilots, flight engineers, and loadmasters crewing a C-5.

MILITARY AND CIVIL DIFFERENCES

It is not our intent to go into detail concerning the content of the CRM training

being developed by United Airlines Services Corporation for the C-5 ATS; rather, we will focus on a number of general differences between military and civil cockpits which may have implications for the development of military CRM programs. These general differences include: (a) military rank; (b) purpose; (c) crew qualifications; (d) crew lifestyle; (e) labor relations; and (f) other, miscellaneous differences.

Military Rank

Various issues related to military rank may provide the largest difference between military and civilian crews. Let's consider several situations.

Rank Reversal. Occasionally, a crew will be headed by an aircraft commander who is junior in rank to others on the crew (e.g., the aircraft commander may be a Captain and the copilot a Lieutenant Colonel). Regardless of the reversal in rank, there is no question that the Captain is in command during the flight and during any ground activity relating to the flight. There is also no question that the Captain must treat the Lieutenant Colonel copilot with more attention to courtesy than would be the case if the copilot were junior in rank.

Another reverse rank situation is that in which a navigator is senior in rank to the aircraft commander. However, this is less likely to induce undue tension since the navigator is not a pilot.

There is no comparable situation in major airline operations in which the Captain is junior to a subordinate in the cockpit.

Officer-Enlisted. Pilots and navigators are commissioned officers, while the engineers and loadmasters are non-commissioned officers (NCOs). This appears to be less of a problem when crew members are experienced than when either or both are relatively inexperienced. When the enlisted crew member is inexperienced, he is probably new at dealing one-on-one with officers, and this may inhibit voluntary communication which should emanate from the new loadmaster or flight engineer. This is even more acute when one of the pilots has a senior rank, such as Lieutenant Colonel or Colonel.

This aspect of the relationship is peculiar to the military. While there are inexperienced flight engineers on airline flight decks, as pilots they have all had experience in dealing with other pilots. Hence, the major inhibiting factor they share with the new military flight engineer is related to inexperience.

A reversal of the situation above occurs when the flight engineer is a very experienced crew member with a top NCO rank, such as Chief or Senior Master Sergeant. When the aircraft commander is new to the airplane and junior in rank, such as First Lieutenant or Captain, the "old head" flight engineer may attempt to dominate the aircraft commander.

It is also possible for a senior aircraft commander and a senior flight engineer to have difficulty in dealing with each other. The situation can be expanded to a senior NCO loadmaster who may have difficulty with a senior aircraft commander and/or a senior flight engineer.

This is not totally unknown in a civil cockpit, but it is much more rare with the passing of "mechanic" engineers in favor of "pilot" engineers on most of the airlines. There are some situations where a senior flight attendant attempts to dominate the cockpit crew.

A number of airlines have an "experience" situation of their own, which the military does not share. The situation occurs with mandatory retirement of the airline Captain at age 60, who then opts to continue his career as a flight engineer. How does he turn off much of what he has learned about flying during his previous 35+ years to concentrate on being a flight engineer? This seems to have the potential to produce an uneasy situation.

Social barriers exist between the officer and non-commissioned crew members. Fraternization is prohibited and, when it occurs, subjects those so engaged to disciplinary action. There are no airline restrictions against fraternizing/socializing with fellow crew members of any position or sex.

Purpose

The primary purpose of our armed forces is to defend the nation against all threats, foreign and domestic. MAC's role is to provide airlift support for that defense. ***The men and women who serve their nation in all of the armed forces do so in response to a number of motivations, such as a desire to travel, an opportunity for education, or simply old-fashioned patriotism.***

MAC crews are expected to fly anywhere, anytime, with cargo or passengers, often to unfamiliar destinations with no local ground support. The crew must handle all the ground arrangements such as service, fueling, loading and unloading, etc. Sometimes the load has political importance such as critical medical equipment or weapons for allied forces. During exercise missions, pressures from Command may be heavy to follow procedures which are contrary to good operating practice.

Airlines flights are generally routine, over familiar routes with standard procedures and navigation aids in the domestic environment. On major airlines, all ground details are handled by specialized company personnel. This varies only during some off-line charter operations, though even there, every attempt is made by the airline to contract for local support. Loads are pretty standard, and extra pressures to deliver a special passenger or cargo are rare.

There is no airline equivalent to the larger role of military aviation, including MAC. In the event of a national emergency, the airlines are ready to supplement MAC operations through the Civil Reserve Air Fleet (CRAF), but in less hazardous environments than those encountered by many MAC crews. During normal times, airline crews serve in response to a different set of motivations which obviously does not include patriotism.

Crew Qualifications

Experience. Within the active force, aircraft commanders probably have an average

of five years as a pilot which translates into 2,000-3,500 hours. Copilots have about two years which equates to 800-1,500 hours. Flight engineers have perhaps seven years, or about 2,500-3,500 hours. Entry level experience may be as little as 260 hours for pilots direct from Undergraduate Pilot Training (UPT), while flight engineers and loadmasters may have zero flight experience.

The average flight crew applicant for major airline employment has over 1,500-2,000 hours, and a majority of the applicants have had previous military flying experience.

Reserve or Guard pilots generally have levels of experience which are significantly higher, and are frequently airline flight crew members. Reserve or Guard flight engineers tend to have longer service but less flight experience than regular Air Force engineers.

Regular Air Force flight experience contrasts with the experience of crew members with a major airline. An airline Captain has at least 10 to 15 years with the company before being promoted to the left seat, or on the order of 7,000-10,000 hours before promotion. A copilot for the same airline spends at least 5-7 years as a flight engineer before being promoted and, excluding time flown as a flight engineer, has 1,500-3,000 hours acquired in the service or in civilian life before employment as an airline crew member. Most airline flight engineers are pilots on the first rung of the cockpit promotion ladder. At the midpoint in the flight engineer assignment (approximately 3 years), they have about 1,800 hours as an engineer plus 1,500-3,000 hours as a pilot before their airline career.

Flight Engineer Qualification: Military flight engineers are obtained from the mechanic ranks, and are not pilots. They are not required to have any formal education beyond high school, except for the appropriate career field training. Their expertise is directed toward aircraft systems rather than toward procedures and techniques appropriate to flying operations. They are not required to have a knowledge of instrument approach procedures, navigation, ATC requirements, etc.

Airline flight engineers are selected for eventual assignment as pilots, and must meet each airline's experience and educational requirements for that position, including piloting experience, licenses, and ratings. Because of their piloting background, they are familiar with instrument approach procedures, navigation, ATC requirements, etc. They also possess the technical knowledge required to perform the functions of flight engineer, as defined by their employer, which generally entails less in-depth knowledge of aircraft systems than is common among military flight engineers. Some airlines, including United, assign flight instrument monitoring or flight procedural duties to their flight engineers.

Turnover. The career path for commissioned flight officers who aspire to higher rank requires an array of academic credentials and a variety of assignments outside the world of flight. Young pilots who are career-oriented begin to look very early for a way out of the cockpit. Earning a Master's degree, and non-flying duties of high visibility are very desirable on an Officer Effectiveness Report, and therefore considered more important to career progression than studying the Flight Manual. Such factors are less important in the Reserve and Guard units; hence, their flight officers are under no career pressure which could cause them to look for non-flying assignments.

The average tour as a pilot within MAC is 2.3 years. This figure varies between seats and fleets, but is true as an average across the Command. "Old heads" remain much longer, perhaps 10 to 15 years, alternating between operational units and training assignments. Younger pilots may be transferred into another command, such as SAC or TAC, frequently into a non-flying job, after three years. Such short tours make it difficult to develop a strong sense of loyalty and devotion to MAC and its larger purpose.

Flight engineers tend to remain longer in MAC. An average is difficult to obtain, but has been estimated as more than 10 years in the C-5 for "old heads," and five years or so for the junior engineers.

Airline "tours" are much longer. Because of the constraints imposed by a seniority system, flight crew members tend to remain with one carrier and develop a sense of togetherness and unity with (or antagonism toward!) their employer. There are changes of seats and equipment, but the policies and objectives of the employer and the relationships with the employees are relatively stable.

Crew Lifestyle

Crew Duties. MAC crews are responsible for a wider variety of ground duties in connection with a flight than are common with most major airlines. For example, the loadmaster is charged with supervising the actual loading and unloading of all cargo, including verification of weight and balance. After landing, the loadmaster is not relieved until the aircraft has been unloaded. The loadmaster or flight engineer prepares the weight and balance forms that are given to the pilots. The flight engineer is charged with overseeing the fueling and verifying that needed maintenance has been performed. As their commander, the aircraft commander is ultimately responsible for the actions of the flight engineers and loadmasters.

Computer flight plans are available for most normal missions, but must be verified in detail by the navigator (if one is carried) or by the pilots. Flight plan filing with ATC is the responsibility of the aircraft commander.

Airliner loading and unloading is the responsibility of airline ground crews. Weight-and-balance forms are prepared by a ground support function and delivered to the cockpit. Flight plans are largely computer-generated, reviewed by a flight dispatcher, and delivered to the pilots for cursory verification and acceptance. Flight plan filing with ATC is handled by the dispatcher.

A MAC aircraft commander is at least partially responsible for his subordinates during ground layovers. For example, if an enlisted person has a run-in with the law, the aircraft commander may be called to provide assistance.

While an airline Captain might be called upon to assist a copilot or flight engineer in similar circumstances, he would be doing so only as a friend. He would not be called for any difficulty involving a flight attendant.

Except for strategic airlift missions, there are no civil equivalents to many of MAC's

missions which frequently require very close coordination and teamwork between all members of the crew, including loadmaster and navigator, to ensure safety.

Crew Scheduling. MAC attempts to lock-in a monthly schedule for aircrew members, but continually changing operational requirements and "add-on" missions create scheduling turbulence which detracts from the crews' quality of life.

Duty days for MAC crews may be as long as 16 hours. With additional crew members assigned to the crew, the day may be extended to as much as 24 hours. There can be several maximum duty days in a row.

Major airline crews have monthly schedules which provide a large measure of stability and predictability in flying assignments. Reserve crew members are available to cover "add-ons" or unavailability of regular crew members. Duty regulations and other work rules make MAC-type work days unlikely, if not impossible, with major airlines.

Labor Relations

There is no formal union among military aircrew members, although there is a strong feeling of fraternity and unity within all ranks. There is an informal flight engineer's "union" which appears to be an "old heads" network which does everything possible to defend its NCOs against the inroads of the officer structure. Peer pressure, attitudes of unit supervisors, and crew position specialists at higher headquarters also contribute to the informal "union."

The relationship with the employer (USAF) is paternalistic and authoritarian. Specific regulations range from those of MAC and the Air Force to the Uniform Code of Military Justice (UCMJ) and govern almost every aspect of life in the military from administrative downgrade to removal from the Air Force. Redress of grievances is difficult and uncertain.

While it is losing members nationally in the face of airline deregulation, the Air Line Pilots Association (ALPA) represents pilots and flight engineers through collective bargaining with their employers. The role of unions is controversial, at best, and in the case of ALPA can cause a dilution of employer authority and diversion of loyalty away from the employer to the union. On the positive side, ALPA provides a strong and influential force for safety in dealing with employers and the government. Airline employers can discipline employees, but are restricted by union intervention. The most severe punishment is dismissal.

Other Differences

Crew Communication. Noise levels and physically-removed work stations mandate the use of the interphone for all intra-crew communications during ground and flying operations. This includes pilots, flight engineers, navigator, and loadmasters. In the C-5, a portion of the system is continually "hot" for communications between the pilot, copilot, flight engineer, navigator station, jump-seat, and avionics bay. Communications to and from other positions requires the use of a push-to-talk switch. Truly "private" conversations are not possible.

Formality in the cockpit (no first names, particularly between officers and enlisted) is mandated by HQ MAC. All interphone communication is, "Engineer, Pilot," or "Co from Pilot," or "Load, Pilot," or "Pilot, Engineer," etc. This MAC procedure is mandated by (a) the officer-enlisted relationship, and (b) the need to communicate via interphone with a crew which may have eight or more members, two or more of whom may share the same first name.

Crew communication in most airline cockpits is more informal, with crew members usually addressed on a first name basis. Cockpit crews are smaller--two or three persons--and there is no need to use interphone. Noise levels in most airline cockpits--and all built by Lockheed, Boeing, or Douglas--are low enough to allow normal cockpit voice communications without resorting to an interphone system. Calls by flight attendants from the passenger compartment employ a separate telephone system.

Training. In MAC, a greater proportion of airplane flight training is carried out in actual flight versus simulation than is customary in the airline world. This includes training on regular, scheduled flights and on dedicated training missions. A much higher proportion of mishaps occurs during training missions than occurs during regular flights. This is explained in part by the inadvertent breakdown in cockpit coordination caused by the diversion of attention from the normal pattern of activities to instruct and supervise the trainee(s). Several gear-up landings and at least one tail strike due to an incorrect speed on approach have occurred on dedicated training missions flown by experienced, well-qualified crews.

Most airlines conduct all training possible, including virtually all non-normal procedures, in simulators because of (a) the operating costs associated with actual airplane operations, and (b) the infinitely greater safety in performing non-normal procedures in simulators versus airplanes. Breakdowns in good cockpit coordination and normal function which can occur during airplane training have no serious or lasting aftermath in a simulator.

IMPLICATIONS FOR CRM TRAINING DEVELOPMENT

DR. WILLIAMS: The differences we have noted between military and civil aircrews have been general considerations for us in our design and development of military CRM training. We find it useful to classify these general differences as either *operational* or *cultural,* even though some of them clearly result from a combination of both operational requirements and cultural imperatives.

Operational Differences

Any differences noted between military and civil operations will have potential implications for designing effective CRM training, but the specific operational differences between and within weapons systems also present even more significant design challenges.

Consider, for example, the operational differences among air frame types just within

the Military Airlift Command. MAC operates a wide variety of fixed- and rotary-wing types. The fixed-wing inventory includes wide-body, narrow-body, propeller-driven, and jet-powered aircraft. Some of these types, especially those classified as strategic airlifters, have principal employments which are roughly similar to their civil counterparts. The C-5 and C-141 are generally thought of as comparable in their principal employments to civil air carrier aircraft. But the C-5 also has a special operations employment (SOE), and the C-141 also has a tactical or airdrop mission.

The C-130, the work horse of MAC, looks to be the same type of aircraft operated by a civil carrier such as Transamerica. In reality, the C-130 performs the widest variety of missions of any fixed-wing aircraft in the Air Force inventory. It is used in greatest numbers as a tactical airlifter to insert and sustain forces wherever and whenever needed. But it is also used for a number of other major missions such as gunship (AC-130), special operations (MC-130), search and rescue (HC-130), and so on.

Each of these major missions, in turn, includes several sub-employments requiring specialized aircrew qualifications. For example, within the tactical airlift mission of the C-130 are various types of airdrops such as HALO, LAPES, sequential heavy, container delivery system, and personnel airdrop. Tactical airlift C-130 crews also qualify for formation lead, special operations low level (SOLL-1), Adverse Weather Aerial Delivery System (AWADS), Primary and Emergency Nuclear Airlift, etc.

The closer one looks at weapons systems even within one Command (and the C-130 is only one example), the more apparent operational differences become. Such differences proliferate across Commands and across service branches. Clearly, operational differences outnumber, and thus perhaps outweigh in significance, operational similarities. In planning military CRM training programs, it may be wise to look upon operational similarities as "differences that don't make a difference."

The significant implication here is that military CRM programs need to be more user-sensitive than civil programs. Civil operations are characterized more by similarities than by differences. Military CRM programs should be more than hasty revisions of generic civil programs. One has to do more than change tail numbers or crew position designators to construct effective military programs. The systematic development of military CRM training programs must involve the end-user heavily and at strategic points in the program development process. At a minimum, the end-user should be involved: (a) in the analysis of training requirements; (b) in a design review of fully-developed course plans; and (c) in systematic acceptance testing of the training package prior to its entering life cycle operation.

The role of the end-user in training requirements analysis is to provide input to what we call "critical requirements analysis." Critical requirements, *from the user's point of view,* are those team tasks which make the difference between performing effectively and ineffectively in the operational environment. A systematic critical requirements analysis should also help identify user plans, resources, and constraints, that could influence course design. How the user might wish to incorporate CRM into existing training plans, the program components that would be selected and configured to fit those plans, resource constraints, and other similar factors should be included in a critical requirements analysis based on end-user input.

After specific learning objectives are determined through a critical requirements analysis, course design proceeds through typical stages such as: (a) assigning objectives to components; (b) assigning candidate activities to objectives; (c) assigning media to activities; and (d) sequencing activities within course components. The output of these design stages is a full-developed course plan. The end-user now makes a second major input to CRM program development through a review of the course plan. The review should validate the training requirements analysis in each aspect of the course plan. That is, the end-user should be able to see that his critical requirements are met by the design and that the design accounts for his existing training plans, resource availability, and constraints. The user's design review should take place before further resources are expended to produce course specifications and materials.

Finally, the end-user should be involved in acceptance testing. A military CRM program should be treated no differently than any other kind of training when it comes to acceptance testing. Acceptance should be based on an initial operational test and evaluation (IOT&E) study which involves trained instructors delivering actual classes of representative students. Continuing acceptance should be based on a systematic program of summative quality control or through a series of follow-on test and evaluation (FOT&E) studies.

Cultural Differences

Civilian organizations interesting in developing CRM training for the military need recognize that they are dealing with a unique institution within society. The military is sanctioned by society as a learned profession in much the same way that medicine, law, and theology are sanctioned as learned professions.

The military is the profession of arms and its social charter is to plan, equip, and train for the possible application of organized force in the service of society. Each component of the military, and ultimately each individual in each component, is entrusted with a mission--"a sending out" to perform a particular service which is ultimately either combat or combat support.

To be entrusted to perform a mission, to be worthy of a mission, requires unconditional commitment. Unconditional commitment is the keystone value in military ethics. It requires that the military professional be willing to forego complete freedom and liberty and live a life based on obedience, discipline, selflessness, and honor.

Like other professions in society, the military retains a sense of corporateness and autonomy through symbolic customs and courtesies. Military customs and courtesies are neither frivolous nor mechanical echoes of tradition. They support, rather, the military value system through material signs of protocol and etiquette and thus bear directly and ultimately upon mission accomplishment.

Charter, mission, and unconditional commitment supported by customs and courtesies cannot be overlooked in planning military CRM programs. Programs that have attempted to do so in the past have not been well-received.

Civilian developers of military CRM programs also need to be aware that the

institutional character of the military is today in direct competition with the concerns of occupationalism. Aircrews today are as concerned with pay and working conditions as their civilian counterparts are. At last year's MAC-wide CRM/CLT conference, attendees were asked, in the context of an exercise, "What is the problem?" Of the forty-three responses to that question, the majority had to do with salary, excessive crew duty, Command pressure, quality of schedule, and similar factors. Essentially the same things surfaced in the course of our critical requirements analysis for the C-5 program. None of our respondents had attended the MAC conference, yet their responses to a similar question during the analysis were virtually identical to those of the conference attendees. These concerns of aircrews today, along with other evidence, suggest economic incentives underlie a fundamental shift in motivation away from professionalism and toward occupationalism.

If there is any point at all in mentioning this motivational shift, it is that CRM program planners should be aware of the key dynamics that are shaping the military today. CRM training itself cannot deal with these dynamics directly, but program planners should be prepared to encounter these crew concerns while, at the same time, honoring traditional military values. The major source of conflict in the military today is between individual needs and organizational goals--the inevitable and omnipresent conflict in any occupation. What CRM programs can do is to help crew members deal effectively with that conflict by helping them redefine and reaffirm those values which are held in balance by an unconditional commitment.

The functional requirements for military CRM program planning must include military as well as individual crew performance objectives. Strong representation of traditional military values must be included at least through a significant Command endorsement. Program components, content areas, and functional relations among components and content are important as in any program design. But, if the instructional strategy does not include a strong integration of military objectives and the concerns of military professionalism with CRM concepts and principles, then the appropriateness, if not the probable success, of CRM training in the military is lessened.

CONCLUSION

As the result of our efforts to date, we believe that military CRM training will contribute to effective team functioning and safe, orderly, and expeditious mission accomplishment to the extent that such training is user-sensitive and explicitly military in character.

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CRM TRAINING IN THE 1550TH COMBAT CREW TRAINING WING

Capt. Michael T. Fiedler
1550th CCTW
Kirtland AFB, NM

Good morning ladies and gentlemen. Today I will be talking to you about the training program the 1550th Combat Crew Training Wing at Kirtland Air Force Base, New Mexico, implemented in September 1985. We call our program Aircrew Coordination Training (ACT), and it is designed specifically to help aircrew members work more effectively as a team in their respective aircraft and hopefully to reduce human factors-related accidents.

I'll begin by describing the scope of the 1550th CCTW's training responsibilities and how we structured our program, and I'll follow with a brief look at the content of the academic part of our course. Then I'll discuss our Mission-Oriented Simulator Training (MOST) program, a program similar to the LOFT programs discussed several times yesterday. Finally, I'll discuss our future plans for our Aircrew Coordination Training Program at the 1550th.

Before discussing the program we developed, it's important to know that all of the 23rd AF's C-130 and heavy-lift helicopter simulators are located at the 1550th. We provide training for 39 of these units--of which 11 are stationed overseas from the Philippines to Germany to Korea to the UK. Prior to our implementation of Aircrew Coordination Training, all of these unit's aircrew members returned annually for a five-day simulator systems refresher course. This program emphasized systems knowledge. Little was said about the crew coordination process.

We developed our ACT program around this five-day week. On day one, we now teach eight hours of aircrew coordination training academics. On day two, we schedule each crew for a MOST period. On days three through five, crews are given both systems academics and systems refresher in the simulator. We feel this mix of crew coordination training and systems review results in proficiency in both areas. We've also introduced this program to the students in our basic qualification courses.

We begin the day of academics with a brief introduction, presenting the students with an overview and goals of the course. For the group exercise, we break the class down into groups of seven or eight, send them to separate rooms, and ask them to list the three most common crew interaction problems they see in their units. When these groups return to our classroom, we discuss these as a class. We then discuss the percentage of accidents caused by operational factors in the civil sector, in the Air Force, and in the aircraft our students fly in MAC. We find that these two steps help students focus on our materials as real problems that affect them, not just as abstract concepts.

We next view a slide-tape presentation of a civil airliner that crashed at Salt Lake City in 1977. We discuss briefly how communications, crew coordination, and other

factors may have played a role in this accident.

We discuss the elements of crew coordination--defined as inquiry, advocacy, conflict resolution, decision-making, and critique. We describe and define the responsibilities of aircrew members to make this pattern work, and reinforce this discussion with examples of civil and military accidents. We also identify the barriers that keep these elements from operating effectively in military crews.

After lunch, we wake everyone up with a video presentation on an Air Saudi accident. We ask the class to note, and then discuss, both good and bad uses by the crew of the elements of crew coordination and discuss the barriers that may have prevented better use of the elements.

We then move into communications. We define communications using a simple communications model and discuss again the aircrew members' responsibilities to make the model work and the barriers that keep the model from being effective in military crews.

We introduce the concept of leadership and followership through the use of a grid, but our primary emphasis is not upon leadership theory. Most of our students have seen that time and again in professional military education. We do identify the characteristics of different leadership and followership styles as they relate to crew behavior and discuss ways of interacting with these styles to work more effectively as crews. We close the day with a summary of key points given in academics, and introduce the students to the MOST sortie they will fly the next day.

Our MOST program is similar to the LOFT program mentioned yesterday by Capt. Shroyer. It is designed to let the crews put the communication and crew coordination theory they learned on day-one into practice in a familiar cockpit environment, and it also allows the crewmembers an opportunity to assess their own style of leadership and followership. The mission is structured to enhance decision-making and crew coordination as opposed to reinforcing emergency procedures.

For those military units planning to incorporate MOST, we installed a black and white camera, a recorder, and a 4" monitor in each simulator. We use this equipment to record the crews' actions and communications during the mission. We built three carts with playback machines and monitors for replaying the tapes during debrief. The audio/video equipment cost $18,800 to purchase and install--this price includes spares. Since our local audio-video squadron does all the maintenance on the equipment such as cleaning we have incurred no additional cost.

The MOST period begins with a short mission briefing conducted by the instructor. He explains the rules for MOST and introduces that day's mission to the crew.

Realism is essential to the success of MOST; the crew must, as much as possible, feel that they are flying an actual mission. Crews must accomplish flight planning, check NOTAMS, obtain a weather brief, and file a flight plan. After crew briefing, they proceed to the simulator where the mission is flown and videotaped. The instructor acts only as an observer. If a crew makes a mistake, they live with it for the rest of the

flight. While the mission is being flown, the instructor will note key points on the videotape counter so he can play them back during debrief.

As mentioned by Capt. Shroyer, our experience has also shown that crews will often recognize their own errors and debrief themselves on the use of the elements of crew coordination, communication, decision-making, and leadership/followership styles. The instructor acts as a moderator, pointing out key areas that need emphasis.

As we approach the end of the first year of our program, we have taken a hard look at what to do for year two. While we will continue to teach our present course to our initial qualification students, we will use a one-day format for our refresher students. Their first day will begin with a two-hour class. They will review basic principles, view a video reenactment of an accident, and critique the accident crew's use of those principles. They will also discuss, with the help of post-accident slides, pertinent Air Force accidents. Then they will plan and fly a MOST scenario and debrief it. Days two through five will continue to be used for systems refresher training.

As of the end of April, 654 students have completed our course, and 97% of them have rated our program effective. We think our program leads to better understanding of the decision-making process and crew coordination, as well as the common barriers to those roles and responsibilities. Our goal, and our hope, is that our crewmembers take what they have learned in ACT academics and practiced in our simulators back to their aircraft and become safer aircrew on the flight line.

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CRM TRAINING IN THE 349TH MILITARY AIRLIFT WING

Maj. John T. Halliday
Lt. Col. Conrad S. Biegalski
Maj. Anthony Inzana
349th MAW
Travis AFB, CA

INTRODUCTION

MAJ. HALLIDAY: Our group is made up of Reservists. We are part-time employees of the Air Force. We are the classic cases of the "citizen solder." I am a pilot for Air California, my partner, Maj. Tony Inzana, is a pilot for Western Airlines, and Lt. Col. Biegalski is a civilian with the federal government. Our Commander, Lt. Col. Bill Jenkins, is a United Airlines pilot and is here with us. Our group has been working in this area for about two years and running seminars for over a year. My own background includes work for United Airlines Services Corporation on their successful bid for the C-5 Aircrew Training System contract.

We have created our program on our own time, on airline trips, or during evenings at home. We built our program on little or no funding. Maj. Inzana personally financed the printing of our CRM questionnaire. CRM training *can* be done on a limited budget.

I want to take a moment to describe a C-5 crew. We are faced with a unique physical plant. We have crewmembers scattered all over an airplane that is the size of a B-747. The minimum crew size is seven, but can grow to a maximum of 22. We have a mix of officers and enlisted crewmembers. They talk by headset and interphone, rather than by simple face-to-face communication.

It seems that everyone has a special name for their CRM program. We have created a new program and selected the title, "Aircrew Resource Management" (ARM) to emphasize the use of the full resources on our aircraft. That is meant to specifically include our loadmasters. The name also emphasizes the concept that *all* crewmembers are responsible for safe completion of the trip. Our loadmasters have been our brightest students to date. We feel they are a classic under-utilized resource. Together, their crew position has been credited with more ARM "saves" than the engineers and pilots.

We have a seminar-based program run by two seminar facilitators that is reinforced by LOFT sessions run by our active-duty counterparts. A complete program would be impossible without their help. We are selecting our seminar facilitators very carefully. Not everyone has the skills needed to serve in this capacity.

We have planned for three phases in the program and are 75% complete through Phase I. The Phase I seminar is made up of a typical ten-member C-5 crew--three pilots, three flight engineers, and four loadmasters. It is a nine-hour training day with

no breaks. Fatigue is part of the course design. It is designed around group interaction and team drills as opposed to a workbook approach. It is also time-intensive. Most of the exercises have a time limit.

We emphasize three main learning objectives: 1) synergy, the concept; 2) the synergy graph--a common language (much of this based upon the work of Dr. Bob Helmreich); 3) the synergy formula--the heart of our program. These three concepts are quickly backed up by case studies and practical exercises to use these new tools to analyze crew behavior and to practice the new ARM skills. The goal of the seminar is to give crews something *practical* to take to the airplane, and this practical information is what the synergy formula is about. We have achieved this, and feel strongly that the seminar *presentation* of the *learning objectives* and ARM *tools packaging* are critical. They must be something the student is comfortable with. These points are as critical as the ARM concepts themselves. For example, we have judiciously inserted conflict into several seminar segments. Carefully managed, conflict is the energy that electrifies the seminar, the role-plays, and the *learning* experience.

We feel that we have several strengths in ARM training, and we have some new concepts under development. Our first strength is the synergy formula. It is the centerpiece of our program and is simple. Another strength is our use of videotape and replay of role-plays. This offers a chance to practice and evaluate the groups' use of new ARM skills. We are forcing LOFT learning objectives identified by our own observations and NASA research down into videotaped role-play. Our objective is to download the LOFT sessions and to provide better personal feedback. This approach has been very successful and opens up the question of the level of required fidelity (of training devices) to train CRM. We are the guys with bathroom plunger that Dr. Helmreich talked about. I'm glad you laughed, our students do too. It is simple, and it's funny, and *it works*. The plunger trains captains to let the copilot fly while he/she manages. The videotape role-play also offers subordinate crew members their first opportunity to observe and analyze the decision-making process.

Another strength is a new team model that we have under development. We also include something we call "Intruder Training"--the insertion of a new crew member into an already formed group. Finally, among other things, we are working on a new role-play design and post-mission critique model.

We have several long-term goals. Among others they are: 1) to seek to induce our crews who fail in CRM to analyze and critique their own work; 2) to incorporate three ARM phases with subsequent phases adding new concepts and reinforcing Phase I skills; 3) to continue basic ARM research with Dr. Bob Helmreich, including research on an active-duty Air Force unit that has not been exposed to any CRM training.

ARM is pervasive in our organization. As examples: 1) ARM is the number one long-term goal of our Commander; 2) we have reorganized our entire unit to promote ARM goals; 3) we will soon be using an ARM attitude inventory to *select-in* the right "new hires"; 4) we have created an ARM staff that reports directly to the Commander; 5) we are using ARM for remediation; 6) our examiners are using Phase I ARM in their corrective action recommendations when they observe poor teamwork; 7) we are creating an ARM critique guide for our check airmen to use on line missions; 8) we will soon be

putting loadmasters into LOFT sessions to promote full teamwork; 9) we have created and are using pilot-coordinated, yet flight engineer-initiated, simulated inflight emergencies for our local training flights, and this really draws the crews together.

Everyone wants to know if CRM works. We feel we are up to about 12 "saves" as the result of our program. As a graphic example, one of our ARM-trained crews recently prevented a repeat of the tragic loss of a 100 million dollar C-5 at Clinton-Sherman Municipal in 1974. Only the copilot, Lt. Col. Jenkins, and the engineer were ARM trained on this recent "save." The brakes had been "capped off" improperly prior to departure by maintenance. Subsequently, the wheel locked during taxi-out. This created a white-hot brake that would have been retracted after takeoff. A serious fire would have ensued. The ARM-trained copilot and engineer voiced their concerns during taxi to the Captain, who was concerned with an on-time takeoff. Their concerns about a locked wheel were initially rebuffed by the Captain. They *persisted,* however, and the Captain stopped to investigate. The "scanner" reported that the brake was "white hot," and the crew and passengers completed a safe emergency evacuation.

Ladies and Gentlemen, we need your help at this workshop. We could use help in developing: 1) a post-mission self-critique model; 2) CRM instructor training; and 3) video support--aircraft crashes, "saves," etc.

One final point--any CRM program is going nowhere without the *open, vocal, visible, support of your organization's leadership.* Our own program has flourished under the leadership of Lt. Col. Jenkins.

I have the pleasure of introducing Lt. Col. "Ski" Biegalski to you. Ski is a civilian Air Reserve Technician in the Civil Service and is a C-5 check airman. He is the Chief of Flight Standards for our Reserve Wing. Ski has worked our program from the start, and is the Wing ARM Program Manager. Ladies and Gentlemen, my partner and good friend, "Ski" Biegalski.

THE SYNERGY FORMULA

LT. COL. BIEGALSKI: I would like to digress, momentarily, from the topic of Cockpit Resource Management or Aircrew Resource Management, and take you back to a time when you owned your first automobile. You were younger then, and your income was substantially lower than it is now. Let's say that your automobile engine had gone kaput. The entire engine is shot, and you don't have the funds to rebuild it. So, what to do? Since you can't afford to pay for someone else to do the job, you'll have to do it yourself, but you don't know how. You have to learn.

A logical move would be to go to your local junior college or vocational school and enroll in a course of instruction on automotive engine theory. Now, though it's true that you need to know about engine theory before you attempt to do the work, after you finish the course and understand how engines work, you still can't rebuild one. So, what's the next step?

You enroll in the next logical course--one specifically dedicated to engine-rebuilding. You finish and finally understand exactly how to rebuild your dead engine, but you are still unable to tear it apart and rebuild it. Why? Because you have no tools and no training in how to use them. So, you finally buy the correct tools and receive appropriate training in their use. And now, you finally have a new *ability* or *skill*, and are finally ready to get out in the driveway, to tear an engine entirely apart, and to rebuild it.

Now, let me return to the subject of this workshop, CRM. The Synergy Formula is our inflight tool, if you will, for problem-solving and decision-making in the cockpit. It enables graduates of our seminar to act/behave better inflight so that the solution they reach will be the result of coordinated group effort instead of the decision of only one person, working from potentially incomplete information.

In our Phase I seminar, we have anywhere from three to four hours of lead-in discussion before we get to the Synergy Formula itself. The formula is the heart of Phase I training. The formal goals of Phase I are twofold: 1) to understand and internalize the formula, and 2) to use it inflight for problem-solving and decision-making.

When does it apply? Whenever group or team-coordinated action is required by the situation. It is my belief that although many problems can be successfully solved by one person, the penalty for incorrect decision-making in an aviation environment is so severe that group problem-solving is almost always the safest solution. A corollary to this theory is that some situations specifically require group problem-solving, in that each person has only a piece of the puzzle and a synergistic solution is required. Without it, unilateral decision-making will almost surely lead to an incomplete and potentially disasterous solution.

Lead-in topics to the formula include motivational information, a discussion of barriers to communication, training in communication skills, and a discussion of behavioral characteristics of individuals in a group problem-solving environment (among other things). This is, in effect, training in a new language which will ultimately enable students to understand, internalize, and apply the Synergy Formula. A side benefit of learning the lead-in material is that students increase their understanding of interactive relationships and increase their communicative skills. It is important to re-emphasize, at this juncture, that our training is quite tool- or skill-oriented. The reason for this is that we are striving to maximize effect in the short time available for training. It is our desire that each crew member literally visualize the formula inflight, as if it were placarded on the instrument panel. Why? Because it is easier to visualize a simple graphic display than it is to remember, consider, and use a list of items.

In our seminar, after teaching and discussing the formula, and prior to initiating role-playing (our method of forcing the internalization process), we hand out three-by-five cards with the formula written on them. We watch as the students actively refer to these cards during role-plays. Final indication that the information is considered valuable is that the students refuse to return the cards. We have little difficulty in recovering any of the other course materials, but the three-by-five cards of the Synergy Formula do not come back--the students take them home.

Figure 1

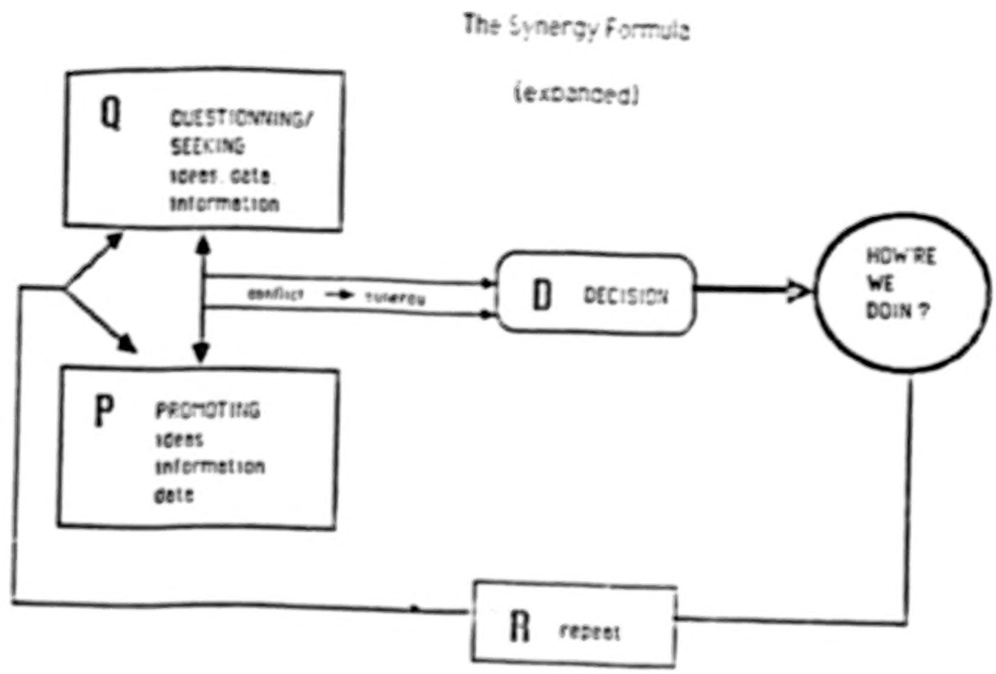


Figure 1 portrays the Synergy Formula. As you can see, the information it contains is not new, although it may be arranged in a somewhat different fashion than you've seen before. There is no real magic about the process of problem-solving and decision-making. Psychology books have contained information on the topic for years. What is new, of course, is the display.

"Q" stands for questioning, seeking, and searching for information, data, and ideas. While this task is not solely the task of the captain or aircraft commander, it is a task which tends to fall primarily on his shoulders. The captain is the person who will ultimately make the decision, and it is quite obviously to his advantage to acquire as much information as possible before making a decision. It must be remembered, however, that not all captains are strong leaders, nor will all captains question effectively. *All* crewmembers have the responsibility for seeing to it that every part of the formula is used.

"P" stands for *promoting*, or advocating the information, data, ideas, needs, requirements, etc., which each member of the crew possesses. Think of this as "placing information on the table" so that the captain can inspect it all at once. An uninformed, or partly-informed captain can hardly be expected to make an appropriate decision. Crucial to the act of promoting, is the delicate art of polite, but aggressive communications. To initiate communication with a confrontational statement tends to destroy the chances of accurate reception. Excessively timid communication, likewise has little chance of success.

Once all the information is "out on the table" (remembering of, of course, that this metaphorical table is in the mind of the captain/aircraft commander), some of it will tend to be in conflict. Needs and requirements of difference sections of the airplane may be dichotomous (we've lost cabin pressure, we have to fly at a higher altitude to make destination, but the passenger with the bad heart will die if we can't keep cabin altitude below 10,000 ft.). Ideas or concepts may be in conflict (so what if the fuel flow gauges are inoperative at both pilot and flight engineer stations . . . we can't safely monitor the engines during takeoff without at least one set of fuel gauges). It is right here that the synergy is developed. In the act of working out the conflicts through a "purification and refinement" of data, the pilot-in-command is able to make a "synergistic decision," one based on more data than was previously available to any single individual on the airplane.

"D" is the decision. Decisions are made by the pilot-in-command. Command authority is statutorily and by regulation assigned to the captain. Command authority may only be removed by removing the pilot-in-command. This is possible in both its physical and figurative sense. Removal from command inflight, however, is a maneuver fraught with danger. Under almost all circumstances, it is the duty of all crewmembers to preserve the authority of command. A flightcrew is not a democratic organization, nor should it be. It is, further, a survivable entity only so long as all decision-making is funneled through the pilot-in-command.

The next step, shown on this slide as "how're we doin?" was one of our biggest stumbling blocks. Getting our guys to *remember* to do an immediate and ongoing inflight review, an assessment of how actions solved (or failed to solve) problems was one of our biggest problems as courseware developers. How did we solve this problem? I need to digress again.

You may have heard of the old airline joke about the company that decided to standardize the names of the cockpit crew positions. To make a long story short, they were trying to avoid the use of first names (Larry, Frank, and John sounded a bit unprofessional, while John, John, and John was downright dangerous). They considered captain, first officer, and second officer, but found this too cumbersome. The management finally settled on the names, "Captain Sir" (for the captain), "Bubba" (for the copilot), and "Hey-Boy" (for the flight engineer). Well, to get back to the Synergy Formula, in our unit we decided not to have any "Hey-Boys." Our airplane flies with the captain in command, and everyone else on the crew gets to be a "Bubba"--captain's little helper. We started calling our immediate inflight review, shown on the slide as "how's it going?" as "Bubba's review," so named because any "Bubba" can call for the review if the captain forgets. All he has to do is wait for that lull in the activity that indicates that the immediate pressure is off and ask for a "Bubba review."

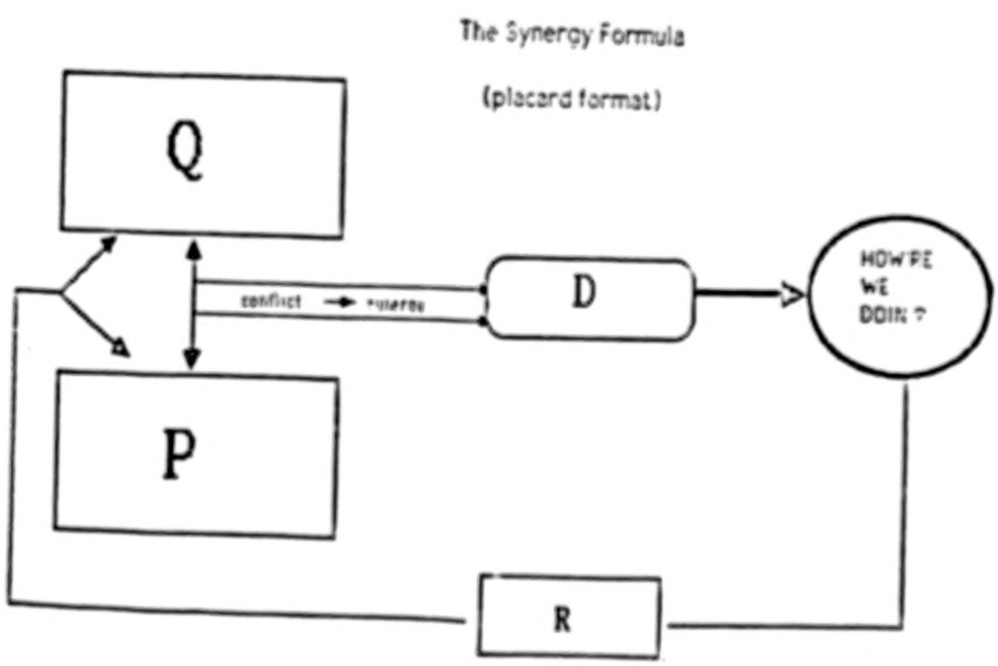
The contents of a "Bubba review" are simple. If the captain has forgotten to inform the crew of his decision, "Bubba" asks, "sir, please announce your decision." The captain must always make his decision clearly known to the flightcrew if he expects to get the right actions in response. Once the decision has been announced, or clarified, the captain asks for a report from all involved crewmembers. He needs to find out how things are going and if he still has problems which need attention. If the optimum solution to all problems has not been achieved, he closes the loop by reinitiating the

Synergy Formula. Repeat this process as many times as necessary.

Why did we insist on using such a dumb name as "Bubba's review?" The answer is simple, the name is so excruciatingly corny that I mentally cringe when I say it, but by the same token, I'll never forget it either. That, of course, is the whole point. *Nobody* can forget it once they've heard it and used it during role-plays. The most important point to be made is that trained crewmembers also remember the "Bubba review" in the cockpit.

Finally, I'll return to the placard theory. This is what we want visualized in the cockpit. If I had control over the airplanes our crews fly, I'd literally placard each panel at each crew station. For the present, we must rely on visualization. That's why it is so important to display and train vital skills in as simplistic and graphic a manner as possible. Most people, particularly crewmembers, resist the use of a memorized list, but can remember a diagram.

Figure 2



Finally, after you've seen an overview of Phase I training, and discussion of the Synergy Formula, the question still remains, does this type of training actually work? Our belief is that it does. Some of our research tells us a very encouraging story about the effectiveness of the training. To present that information to you, I'll introduce Maj. Tony Inzana, the third member of or ACM Development Team. He is a pilot in the 312th MAS and a pilot for Western Airlines. He is also one of our primary seminar

leaders.

MAJ. INZANA: One of the tasks of this workshop is to help answer the question, "Is cockpit or aircrew resource management training effective?" Do we know? If not, how do we find out? I wish it were as simple asking for, "the envelope please?" However, with help and sincere thanks to Drs. Foushee, Kanki, Helmreich, and Wilhelm, who have flown with us, attended seminars with us, and provided an invaluable sounding-board for us, we can shed some light on this question. We can show that a seminar-based aircrew resource management program when carefully crafted and supported by videotaped role-play, can change attitudes positively on the flight deck.

The findings help to verify our approach to the training, and the information obtained allows the administrator to tailor his presentation to meet the needs and unique requirements of our student population. It gives him the ability to design the program for the people, as opposed to trying to fit the people into the program.

We surveyed over 250 crew members in an effort to: 1) establish the first data base applicable to military air crews on the effectiveness of aircrew resource management training; and 2) to improve our implementation of that program. We enjoyed a 90% response rate to our survey. The results indicate that the students developed a highly receptive and improving attitude toward the seminar format in the areas that we selected for emphasis. However, student receptivity does not necessarily validate a concept of training or courseware content. Just because a student is in favor of a course, or its format or mode of presentation, does not necessarily mean that it is effective as an educational or learning process. But, the survey, which gathered personality and attitudinal data from our pilots prior to undergoing formal resource management training, suggests that some positive change is occurring.

To those who had had such training, we asked questions with respect to their own opinions of the value of the training they had experienced. For those who had not had such training, we asked questions in two key areas. First, we wanted to know if they had heard of CRM training either in the military or civilian world. Approximately 90% of those who had not had such training were aware of it. Eighty percent of crewmembers who had not had CRM training felt that it would be of benefit to them personally. Seventy-five percent of our respondents had flown with someone who had undergone CRM training and felt that those individuals demonstrated recognizable behavioral changes.

Finally, we asked if crew coordination had been improved as a result of aircrew resource management training, and 80% of those untrained individuals felt they had observed better coordination and flightdeck atmosphere from those crewmembers who had undergone training. We feel these results are fascinating and suggest that improvement is underway as a result of this type of training. For example, in a videotaped role play in a recent seminar, a crusty 20+ year pilot was faced with three bad choices. He was unable to solve his in-flight dilemma himself, and you should have seen the impact on the pilot's face (on video replay) when the solution was provided by the junior loadmaster (physically removed from the flight deck by 100 feet). The visual relief that slowly surfaced on that screen for all who were present was unquestionably real and was seen by all who were present.

Ladies and gentlemen, resource management training works. Thank you.

DISCUSSION

CAPT. CARROLL: If I understood correctly, you made a reference to a failed crewmember in this particular program being brought back or given additional exposure. Was my understanding correct? And if so, I'd be very interested in knowing how you recognized the deficiency, how you brought it to their attention, and what action was taken.

MAJ. HALLIDAY: This individual's problem was seen on an annual flight evaluation. He does have a problem, a known problem in the area of aircrew resource management. We think that we now have the tools to pick that up. He failed his flight evaluation not for lack of technical skills, but for inadequate resource management skills. He had already been a Phase I resource management graduate, but I guess it did not take. He was one of our worst students. We since re-entered him into our program in an effort to help him, but I think that it was an experiment that so far has had only limited results. I think he is a case of the problem crewmember that was raised yesterday, and that we perhaps need a far more powerful vehicle than a seminar to solve such a person's personal problems. Does that answer your question?

CAPT. CARROLL: Yes, but may I take it a little bit further? Because, I am going to be chairing a group that is going to be asking about how you can assess the effectiveness of training and so on. So I think this input is going to help us. Was there an assessment or a recognition at the time of this individual's problem that the rest of the crew had made an effort to help or support or obviate his concerns or problems? In the past, the question has been raised in the civilian environment: Can a whole crew fail a proficiency check when perhaps it's the primary problem of one individual's technical competence? I would like to extend this now into the area of resource management. Was the crew effective in trying to work with that individual?

LT. COL. BIEGALSKI: Ed, I share your concerns on this topic. To address that question the best I can say is there are no real guidelines to follow in this area that we have been able to find. We had a presentation on retraining the recalcitrant crewmember yesterday, and I spoke to that presentor, but was unable to get much more of a resolution to the problem than we already had. What we are attempting to do is not only deal with individual crewmembers who fail a checkride for resource management reasons, but we are also looking at flight crews who will come back periodically and report anecdotally that such and such happened, and that they could have done a better job. Or maybe they thought they did a good job, but we feel that they could have done a better job. What we attempt to do is to reform the crew, discuss the whole thing, rehash the situation in resource management terms and analyze it--hoping for a degree of success. We hope this success will be realized in terms of individuals' recognition of failures and their dedicated intent to try to go out and do better. We have had limited success. I will use myself as an example. I am a particularly hard-sell on that. I have a tendency to think with a single-seat mentality. It is a constant battle on my part to overcome that. I am not alone in this battle. Pilots

have a tendency to be individuals. In an attempt to get other crewmembers to be more promoting and sharing of information and to be more receptive, we find that they sometimes say, "Golly you're right, I screwed up--I'm going to do better next time." That doesn't mean that they will, but we have at least successfully provided recognition and motivation to improve.

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CRM FOR PART 91 AND 135 OPERATIONS

Neil C. Krey
Don Rodgers
SimuFlite, Inc.

INTRODUCTION

Every flight is characterized by constant change. It is the way each individual crew responds to that change that determines how effectively they will be able to manage their flight deck. In this paper we would like to first present the concepts of Flight Deck Management (FDM). We feel that the principles we are dealing with are applicable to every flight, and that the occurrence of change in the conduct of every flight is a given. Nothing remains as it is initially perceived.

We will then show how SimuFlite accomplishes training in these concepts. Finally we will discuss the challenges which we face as an industry to make FDM more effective.

We will lead off with an issue, which in the two and one-half years we have been providing training to the FAR 91 and 135 operator, we have found critical to the study of cockpit resource management, which to date none of us in the industry has dealt with very successfully. We do this by posing a question which is closely akin to, "do you know where your kids are tonight?"

The Question

Most of us have at least one crew in the air right now. Each of those crews is facing changes that they didn't anticipate. How comfortable are you that your crew is able to recognize those challenges and how confident are you that they will respond to them effectively?

In considering this question and thinking about your pilots' potential ability to deal successfully with the unexpected you can feel confident that they understand and accept the criticality of the aircraft's operating envelopes. These envelopes are precisely defined by the laws of physics, relating to g-forces, airspeed, and altitude. But we submit that there is another envelope which many pilots don't understand, and more importantly, don't accept as important to safe, successful flight.

The pilot's own Safe Operating Envelope has not been adequately defined up to this point, and only recently have we begun to realize its significance. In addition, the individual pilot's psyche may reject its existence through his drive for survival, dominance, and uniqueness. These drives deny the thought that he is susceptible to the consequences of exceeding *his* limits.

We want to say up front that we don't have a suitable solution for this issue, nor do we know anyone who has. We do know that cockpit resource management faces several crucial challenges. These include:

- o How do we get the average pilot's acceptance of his limitations?

- o How do we train the pilot to accurately understand these limitations?

The Needed Skills

This rejection of human limitations is sometimes known as the "silk scarf" syndrome. The individual pilot perceives himself as courageous, self-reliant, capable, and even invulnerable.

His focus is on developing and maintaining his individual abilities. He strives for a high level of proficiency in his flying skills and places great importance on his understanding of the intricacies of his machine. He recognizes his need to be able to plan and navigate accurately while coping with the environment. As our aircraft and the ways we use them have become more complex, we have put several of these self-focused pilots together to form crews. Our focus on the individual is so imbedded in our aviation culture that even today we only check our pilots' proficiency on individual skill criteria.

Our job in Flight Deck Management training is to expand the pilot's skill set, enabling him to interact effectively as part of a team. Effective use of standard operating procedures (SOP's) is the foundation of the flight crew's team orientation, yet it often runs counter to the individual pilot's self-image. The skills, which allow the individual to interact with other human beings around him and to manage his flight deck in a constantly changing environment, require the same dedication and hard work to master as the more traditional skills have.

Among the "laws of the flight universe" (along with the aircraft and pilot's envelopes) there is another principle of successful flight which relates to the performance of the human in the cockpit. In a sense, the issue in Flight Deck Management relates to the crew's state of mind at all times in relation to this law. SimuFlite has defined this principle as the FDM Cycle.

The Flight Deck Management Cycle

The FDM Cycle is as fundamental to a successful flight as any of the physical cycles relating to flight. The FDM Cycle is represented by a triangle. The base of the triangle represents the crew's development of an accurate and comprehensive concept of how the flight is going to be successfully accomplished. This process develops the ***plan***.

As the crew conducts the flight, they remain alert for events which conflict with the *plan*. Once these *challenges* are recognized and validated, the crew must generate an appropriate *response*. On the basis of the changed situation, the crew then returns to the base of the triangle, revising their *plan* for the successful completion of the remainder of the flight.

Flight Deck Management trains crews to develop the state of mind to recognize where they are in the FDM Cycle and to maintain the integrity of the cycle without

allowing a breakdown. Let us look at the three steps of the FDM Cycle in detail, and examine the crew skills necessary for high levels of performance in each step.

The Plan

As we look at the first step of the process, establishing a plan, we need to do so as if through a pair of bifocals. Through half of the lens, we see company management's foundation, or plan, for how all flights are to be conducted. This foundation layer consists of policies, procedures, and the company culture. It represents a considered resolution of the sometimes conflicting demands of safety versus the mission objective. This foundation is laid well before the flight is scheduled.

Through the other half of the lens we see the crew establishing a plan for this specific flight. The plan represents a common, collective concept of the flight, from block-out to block-in. (Figure 1)

Skills to Develop the Plan

The crew's use of it's Flight Deck Management skills begins with development of a plan for conduct of the flight. This process requires sound knowledge and application of the standard operating procedures, as well as other policies and regulations. Skill at accessing all available resources ensures development of suitable options and evaluation of the relative risk of each. Effective communication provides each crewmember with input opportunities in the decision-making process. The pilot holding command responsibility for the flight must communicate the selected plan to each crewmember, making certain that each of them shares a common image of how the flight will be conducted. At SimuFlite, the crew is taught a communications model which deals with how people interact, how information is processed, and how decisions are made.

The model places emphasis on the recognition of other crewmember's normal communications "style" and develops the ability to self-adapt to those differences which exist.

The Challenge

The second and inevitable step of the FDM Cycle is that there *will be* a challenge to the initial perception of how the flight will proceed. This is often the source of the flight operations manager's nagging concern:

- o Will the flight crew notice the change?

- o More importantly, will they see it properly?

So, Flight Deck Management's training objectives are to develop the crew's state of mind for constant vigilance to challenges (Figure 2), and to allow the crew to properly validate those challenges. (Figure 3)

Skills to Recognize and Validate Challenges

The search for challenges as the flight progresses requires various skills as the crew monitors events both on the flight deck and in the world outside. The pilot in command must ensure that his resources are used effectively so the crew may detect events which do not match the commonly-shared plan. Each crewmember holds an obligation to communicate with the others anything that may constitute a challenge, without allowing it to be colored by individual bias. Individual perceptions can then be combined as the challenge is verified.

The Response

Though safety of flight depends upon a high level of performance by the crew in each step of the FDM Cycle, the third step of *response,* it seems, is where the crew is most likely to drop the ball. The first cardinal sin in dealing with change in a multi-place aircraft is the failure to fly the aircraft. In a list of inappropriate responses to any challenge, this single critical failure is at the top of the list.

The crew's response to a challenge depends heavily on the time element:

o Time-soft situations do not immediately threaten the aircraft's or crew's envelopes, and provide the opportunity for analysis and discussion of the situation. (Figure 4)

o Time-critical situations allow little or no time for delay or trouble shooting. This type of situation requires knowledge of SOP and emergency procedure memory items in order to deal with them effectively. (Figure 5)

The crew is always obligated to select a conservative response. This means the one which best moves the aircraft or the crew away from the edge of the envelope.

Skills to Make a Response

To effectively respond to a challenge, the crew must exercise the full range of their flight deck management skills. With time-critical challenges, the ability to accurately follow SOP and immediate action checklist items enables the crew to stabilize critical situations. Given a challenge which is less demanding, the crew distributes workload to allow effective use of all applicable resources. Analysis of an ambiguous problem may be undertaken, requiring well-developed decision-making skills to select an appropriate course of action from those which may be available. The control of stress within the crew is essential to optimizing their collective effectiveness.

The Chain of FDM Cycles

Once the crew has properly responded to a challenge with a clear picture in their collective minds as to where the aircraft is in the envelope and relative to the mission

objective, the crew then moves back to the base of the triangle. They establish a new plan, and in doing so, form a new concept of how the flight will proceed to a successful conclusion. (Figure 6)

Having shared their new flight concept, the crew now remains alert for new challenges. Successful flight crews are able to deal soundly and effectively with each step of the FDM Cycle. Those crews who fail to perform adequately during a cycle, however, set themselves up for an incident or accident.

In keeping with SimuFlite's premise that there are not any pilot-error accidents, but rather pilot-preventable accidents, we find that virtually all accidents are the result, not of a catastrophic, sudden failure of one step in a cycle, but rather of poor performance by the crew in several subsequent series of cycles. Thus, in an approach and landing accident there may have been a critical failure of the crew to perform somewhere much earlier in the flight profile. As an example, an analysis of several wind shear accidents reveals challenges which were not recognized or for which inappropriate responses were generated well before the actual encounter with the violent shear.

To summarize the objectives of Flight Deck Management training, SimuFlite endeavors to:

o Obtain the pilot's "buy-in" to his vital role in the application of sound management to complete the flight successfully.

o Develop understanding of the FDM Cycle--the process so important to dealing with constant change in aircraft operations.

o Exercise the skills required to successfully implement the FDM Cycle.

A safe flight operation, then, incorporates two vital links:

o The crew's faithful adherence to the published SOP as a basis for effective management of the flight deck.

o A high degree of performance as the crew encounters each step of a series of FDM Cycles during a mission or flight.

FDM Training at SimuFlite

At SimuFlite, we have infused the principles of Flight Deck Management throughout all of our activities. A 3-day interactive workshop on Flight Deck Management skills is available to all clients, and is required for those participating in the Upgrade program. In all other facets of training activity, including ground school and simulator, Flight Deck Management is one of the primary instructional objectives. In initiating the attempt to get pilot buy-in on the importance of training in the Flight Deck Management skills, emphasis is placed on the high percentage of accidents which are crew-preventable.

Three-Day FDM Workshop

During the 3-day Flight Deck Management Workshop, the crew explores the various skills which are used when functioning at peak effectiveness on the flight deck. Activities include multi-media presentations on past accidents and incidents to provide insights into how proper use of the Flight Deck Management Cycle can break a developing chain-of-events before the situation becomes critical.

Crews also have the opportunity to practice using their skills with carefully-developed scenarios. One scenario, for example, builds a situation in which the crew is under considerable self-induced pressure to complete a multi-leg flight. The flight progresses toward its ultimate destination where weather in the vicinity of the airport is questionable. A building chain-of-challenges, which began early in the day, culminates on an approach into La Guardia where the crew encounters wind shear.

FDM Training in Aircraft Programs

As we look at the techniques which SimuFlite uses to infuse Flight Deck Management into it's aircraft training programs, think about management's role in that first step of the Flight Deck Management cycle--that of supplying established, published procedures for use by the flight crew. In practice, many of SimuFlite's FAR 91 and 135 clients do not provide such written procedures. To fill this gap, we have developed a consistent set of procedures and information resources across all aircraft programs as part of SimuFlite's commitment to effective Flight Deck Management. These materials are designed to enhance operational efficiency, and include:

o Reference Handbook, containing limitations and technical information about the aircraft.

o Operations Handbook, which include checklists and tabulated performance data.

It should be noted that the Reference Handbook has one section which is procedural in nature. This is the standard operating procedures section. If a client already has developed an SOP which he uses in his flight operations, then we train in accordance with his own SOP. If he does not, then we suggest that he use the SimuFlite SOP as the basis for developing his own. We also use this document for basic callouts during training and evaluation.

In the classroom, the crews participate in the dynamics of the Flight Deck Management Cycle. Activities include instructor pilot-conducted interactive discussion of a representative mission scenario. Each instructor is an ATP-rated pilot, who is also rated and experienced in the aircraft type, and thus able to present operationally believable situations. The crews are given aircraft, mission, and weather information to build their concept of the flight, and the instructor then introduces challenges to alter that concept.

An example of a typical scenario would be a crew that is holding short of the runway for takeoff. The runway comfortably exceeds the required field length requirement under the existing conditions. The instructor then informs them that the planned takeoff runway has been closed due to a gear-up landing by another aircraft.

With the aircraft heavy, and the weather marginal for use of the remaining runway, the crew is now presented with some ambiguous challenges requiring them to communicate effectively to achieve agreement and validation of what the challenges are.

Next, the crew must access resources other than the tabulated data located in their operations handbook. In order to facilitate a response in this case, the aircraft's second segment climb charts are required in order to resolve flap configuration questions. After the crew formulates an appropriate response, they brief the new concept for the takeoff and climb. As the flight continues following takeoff, the instructor introduces repeated challenges. This activity requires that the crewmembers use proper callouts and communicate how they would validate or confirm what the challenge is, resolving any ambiguity.

Depending on the amount of time available, the crew gives their response based first on their SOP, and then on an exercise of their other crew skills. Through well-placed open probes, the instructor leads an interactive discussion and practice of all of those skills. When the response is considered complete, the crew members complete the cycle by moving into the first step of the succeeding cycle--they establish a revised plan. They develop a new concept of how the flight will proceed based upon the revised aircraft configuration or flight conditions. In one case, the crew has limited pressurization capability and must consider the alternatives for proceeding with their flight. They must agree upon and ensure a mutual understanding of a new plan. In the classroom, crews practice going through this cycle to understand the skills necessary to complete it successfully.

FDM in the Simulator

All flight simulator training at SimuFlite uses the Line-Oriented Simulation (LOS) or mission-oriented format. Even during the so-called batting-practice sessions, crews are carefully put into a frame-of-mind which enhances their ability to respond to challenges as they would in the aircraft. During the one-hour briefing, the crew plans the flight as if it were to be conducted in the aircraft. This activity includes sharing of the flight concept through a thorough crew briefing.

Integral to the effective presentation of Flight Deck Management training is the integration of the company-specific SOP into the training. This information is provided to the instructor as a part of the crew records, and becomes a topic for evaluation of the crew's performance.

The scenarios presented to each crew are designed to take maximum advantage of SimuFlite's Phase II-certified simulators. Each scenario includes carefully selected challenges which exercise the full range of Flight Deck Management skills, while providing the individual pilot with the appropriate progressive check in most courses.

The instructor acts to maintain the realism of the training flight, intervening only to provide remediation. The instructor is aided in his role as air traffic controller by SimuFlite's unique Air Traffic Audio Simulation System (A-TASS) which provides realistic background communications, instructor voice modification, and Automatic Terminal Information Service (ATIS) capabilities.

Low-light-level video cameras and strategically-placed microphones allow the crew to receive valuable feedback on their performance and to compare their self-image with reality during the debriefing. All instructors are trained intensively on interactive techniques to help promote self-debriefing by the crews.

An additional tool available to improve crew awareness of their performance is the ability to produce computer-generated maps and approach profiles of all phases of flight.

When evaluating the crews' performances, their ability to effectively use Flight Deck Management skills is given high priority, as demonstrated by the operational qualification items on the first page of each crew member's performance record. The items evaluated include planning, use of SOP, decision-making, and use of resources.

Line Oriented Flight Training (LOFT) is the last simulator flight in all courses, including transition and recurrent. The charter for the Instructor Pilot is to "set the stage" in the crew's mind for the operational flight or mission, after he has briefed them on the objectives of the flight--to exercise all of their management skills as effectively as possible.

The two-leg LOFT flight is structured carefully to follow NASA and FAA guidelines and incorporates carefully-controlled workload with believable weather, air traffic, aircraft malfunctions, distractions, subtle coercion, and other embedded challenges.

It is here that our 2-month Instructor Pilot Training Program in Flight Deck Management communication skills, delivery skills, and operation of SimuFlight's Phase II simulators pays off. In order to continuously maintain the flight's realism, the instructor must be an accurate and credible air traffic controller. He must successfully orchestrate all of his instructional resources to keep ahead of the crew and set up realistic conditions in response to the crew's selection of options. LOFT realism also requires an extensive airways network and a large number of airport databases.

The effectiveness of LOFT, and concurrently some measure of the crew's regard for Flight Deck Management training are indicated on the last page of SimuFlite's Client Feedback Critique. The first is where they evaluate the realism and usefulness of LOFT on a scale of 1 to 5. Ratings in this area are consistently 4s and 5s, with the average at 4.8. In the overall evaluation of training, our program effectiveness is confirmed by their feeling of completing a satisfying total training experience. A common comment is: "I learned more about myself as a pilot in this session than in all my previous training...."

Scope of SimuFlite Training

Training operations which SimuFlite is currently conducting include training for corporate and FAR Part 135 jet and turbo-prop operators, U.S. Navy and U.S. Marine pilots, FAA, and foreign government agency inspectors.

This same training will be integrated into our support of the Singer Company's new roles at training centers in Totawa, New Jersey with large transport-category aircraft and at Marietta, Georgia on the C-130 "Hercules."

CONCLUSION

In summarizing, we must revisit the opening question of this paper and ask ourselves if we are confident that our crews are successfully dealing with the changes which they are encountering? If not, then our discomfort lies not in our failure to know what skills they need. There is common agreement on what those skills are, we have just given them different names. Rather, that discomfort comes from our uncertainty over whether the flight crew member has "bought-in" with us that he *can* have deficiencies in those skills, and over our knowledge that the training process needs improvement.

There is a nugget of training wisdom which has been referred to several times during this workshop which can be phrased this way:

o Tell me and I'll forget,

o Show me and I'll remember, but

o Involve me and I'll understand.

Understanding is the vital goal of Flight Deck Management because only when the pilot reaches this training level does he behave as an effective crewmember. At SimuFlite, we have designed a Flight Deck Management course, classroom scenarios, and simulator training under this premise.

As we have seen by the client feedback critiques, we feel we are doing something valuable, but we see opportunities for improvement in this emerging area of training:

o First, how do we do a good, consistent job of getting pilot "buy-in" up-front for Flight Deck Management training (in other words, his acceptance of his own envelope of human limitations)?

o Second, all of industry must commit to training CREWS on multi-place aircraft vs. individual pilots. Rating and proficiency checks must verify acceptable proficiency in crew skills.

o Finally, we need to clearly define criteria which can be used to measure crew performance.

We are pleased to be able to participate in this workshop, and look forward to working with each of you to continue the development of Flight Deck Management training.

Figure 1

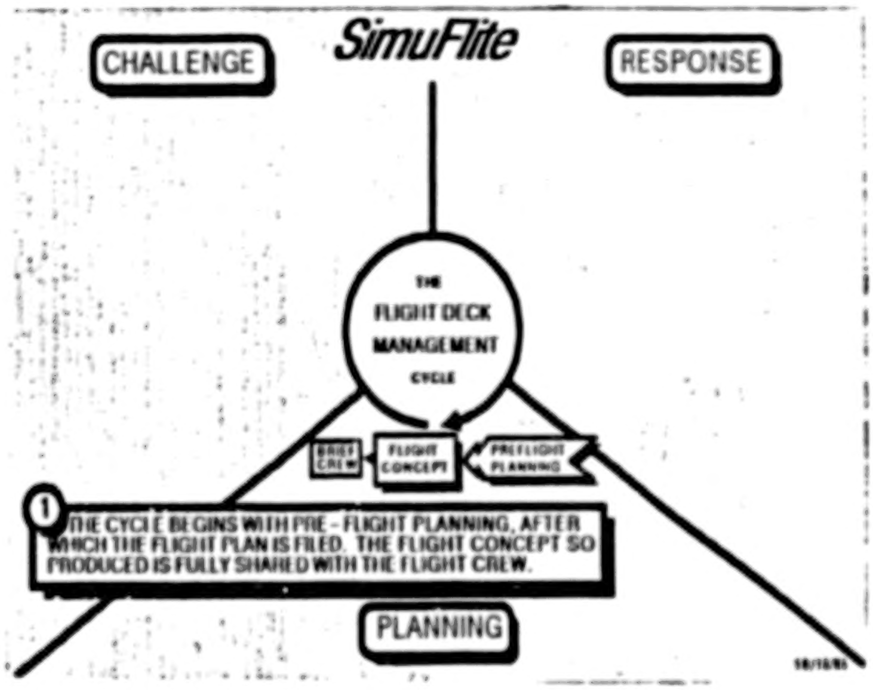

Figure 2

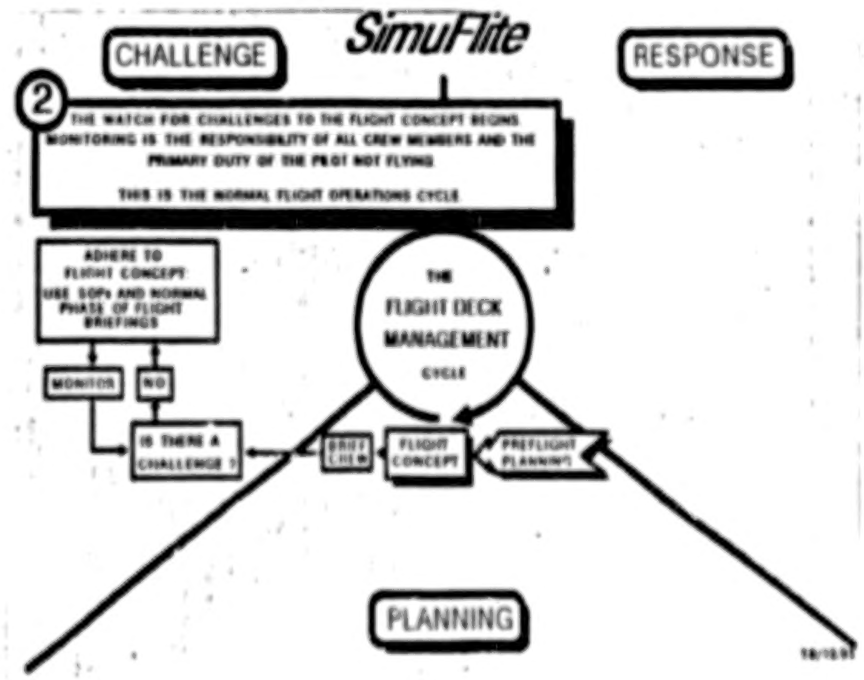

Figure 3

ORIGINAL PAGE IS
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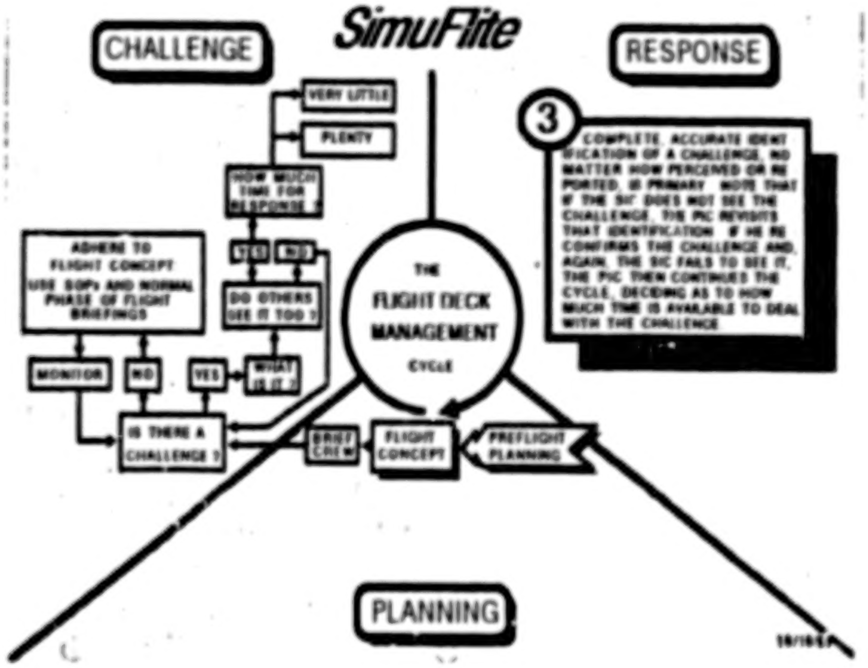

Figure 4

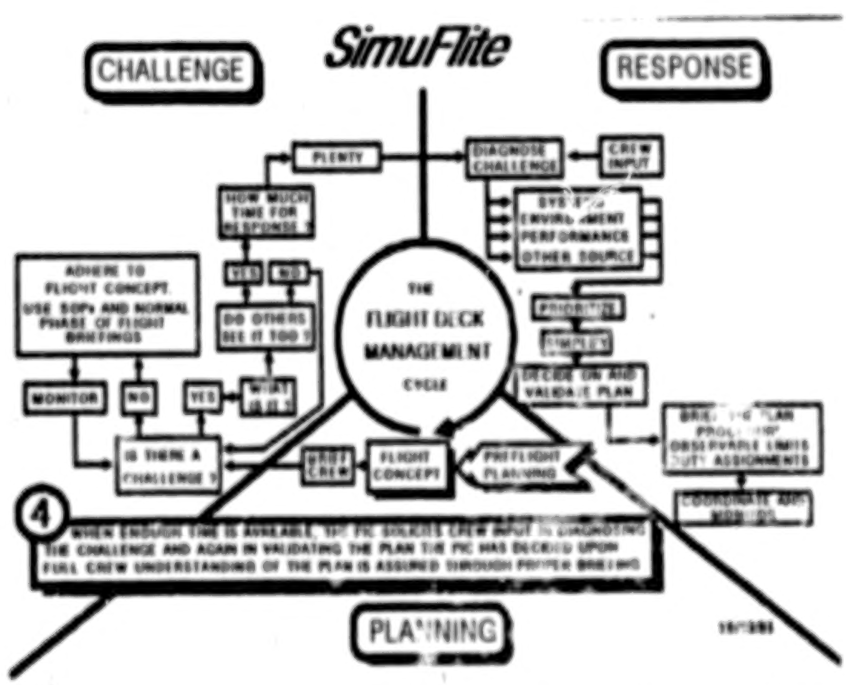

Figure 5

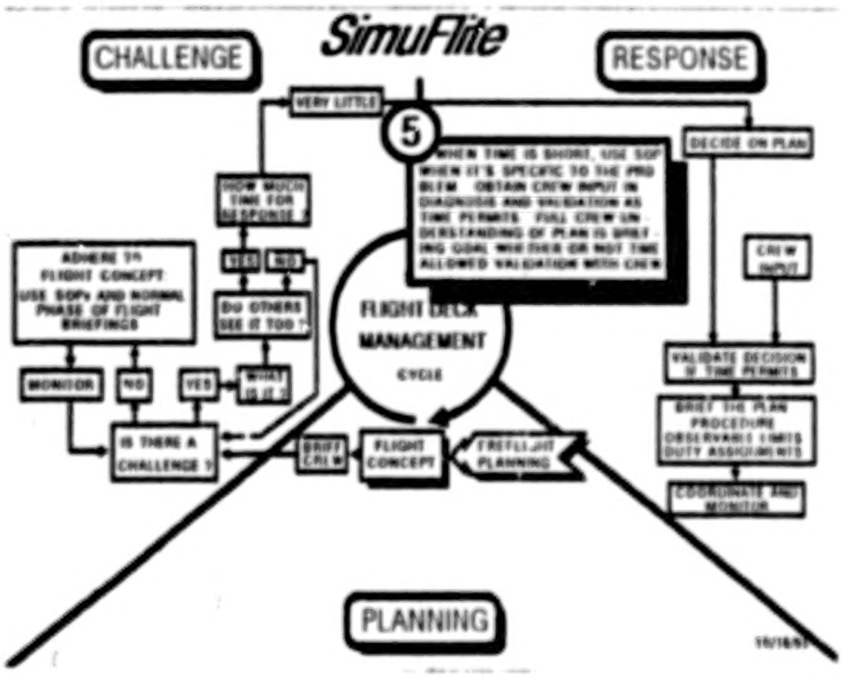

Figure 6

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CRM Training for FAR Parts 91 and 135 Operators

Douglas Schwartz
Flight Safety International, Inc.

INTRODUCTION

In the next few minutes I would like to tell you about the why, what, and how of CRM at Flight Safety International (FSI)--that is, the philosophy behind our program, the content of our program, and some insight regarding how we deliver that to the pilot. I will touch on a few of the concepts that are part of our program. This will include a view of statistics we call the "Safety Window," the concept of situational awareness, and an approach to training that we call the Cockpit Management Concept (CMC).

For those not familiar with Flight Safety, it may be useful to know a little about us. Flight Safety is in the training business. It is the only thing we do. One distinguishing characteristic of the pilot training we do is that the pilots we train do not work for us--we work for them.

FSI was founded in 1951 by A. L. Uettschi, a Pan Am pilot. We currently provide initial and recurrent training to over 20,000 professional pilots a year. There are over four hundred full-time, flight, ground, and simulator instructors employed by the company. We operate a fleet of seventy-five flight simulators which are dispersed among twenty-five Learning Centers in North America and two in Europe. Our growing fleet covers the entire gamut of corporate and airline equipment including MD-80, B-737, B-727, DC-10, and A-300 aircraft. Accordingly, each simulator represents the state-of-the-art at the time of manufacture. Levels of equipment include Phase II, Phase I, visual, non-visual, and training devices.

FSI has two divisions which provide support for pilot training operations. Communication Systems Division (CSD), located in Houston, Texas, which develops and produces training support materials, including manuals, slides, and video, as well as providing a focal point for course development. Our Simulation Systems Division (SSD) in Tulsa, Oklahoma designs and builds training equipment including flight simulators, cockpit system simulators, and part-task trainers.

The topic I have been asked to speak on relates to CRM training for 91, 135 and corporate operators. It is often assumed that there are major differences between these segments of aviation and airline and military operations. However, these differences are primarily organizational rather than operational. Hence, we do not distinguish in our CRM training between Part 135 operators, Part 91 operators, or Part 121 operators. That is, we believe when an airplane is being vectored to final approach in critical weather, or in any other condition, the needs of a flight crew don't vary according to the style of their operation or the kind of organization they fly for. Our CRM training also does not distinguish between training for captains, co-pilots, second officers, or any other crew members.

C-3

Flexibility is a key factor in CRM training at Flight Safety. We have a large operation that provides in-house training, sets standards, and develops programs on the basis of need. Training programs vary from one airline to another. At FSI we train crews for over 1800 corporations plus airlines, government agencies, and the military. Each has a different view of how to train, how to fly an airplane, and how to address CRM. CRM training at FSI is designed with a flexible delivery approach that allows it to be easily adapted to various needs.

The philosophy behind the cockpit resource management training we do at FSI begins with what we call the "Safety Window." The Safety Window represents a statistical view of accidents and accident causes over the past number of years. The Safety Window is defined as a block of airspace centered around a runway extending from the ground to 2,000 feet AGL. The window begins at or about a final approach fix and ends at the approximate conclusion of the final segment of take-off climb. It includes the approach, landing, taxi, take-off, and climb phases of flight.

An analysis of the Safety Window yields the following observations:

- o The window represents only 7 percent of total flight time (based on an average stage length of 75 minutes).

- o More than 80 percent of accidents and incidents involving professional pilots occur in the window.

- o Most of these events are generic. That is they are accidents that have as a root cause some sort of crew management error rather than a mechanical failure.

- o Crew workload intensity peaks within the window.

If this window of risk or exposure is so important, what can we learn from it? Should one leave the window if something goes wrong? Or, should you stay in the window? There is evidence to indicate that either choice might be appropriate, depending on conditions. What criteria should one use to make that choice?

This led us to the concept of "Situational Awareness." It is the heart of the cockpit resource management training that we do at Flight Safety. Situational awareness is an accurate perception of the factors and conditions that affect an aircraft and a flight crew during a specific period of time. In more simple terms, it is knowing what goes on around you.

This is a back-to-basics concept. At the start of primary training, pilots are taught the need to "think ahead of the aircraft"--situational awareness. We find that our flight instructors routinely have to remind highly-experienced professional pilots of this need to think ahead.

It is important to note that situational awareness has a very direct relationship to

safety. It is a simple one. The more a pilot knows about what is going on around him, the safer he will be, and the less he knows about what goes on around him, the less safe he will be.

The best illustration of this relationship is the safety record of drunk drivers. This is an area of growing national concern. Characteristics common to drunk drivers are--an unfounded sense of well-being, impaired hand-eye coordination, dulled senses, and slowed reaction time. Drunk drivers have more accidents because they have less control over their situation--they don't know what is going on around them. In other words, they have low situational awareness.

It is important to stress the contribution that situational awareness makes toward safety. Because safety is the operational goal and there is such a strong relationship between the two, we believe that the goal of any pilot training program should be to enable a crew to reach a higher level of situational awareness in operating their aircraft.

ESSENTIAL ELEMENTS OF SITUATIONAL AWARENESS

We have identified five elements that contribute to situational awareness: 1) experience and training; 2) physical flying skills; 3) spatial orientation; 4) cockpit management skills; and 5) health and attitude. Each is discussed below.

Experience and Training

We describe experience as a mental file or experience file that every pilot uses to assess conditions and make decisions throughout the progress of a flight. Study of human performance indicates that when an individual is put under a great deal of pressure, the tendency is for that individual to revert to a previously established pattern of behavior. Therefore, if you can instill within an individual's experience file the desired response to stimuli, there is more likelihood of a safe and desirable outcome.

Experience ties directly to training. They cannot be separated. Many situations have the potential to occur in flight, but are unlikely to do so. The training process is used to expand an experience file by creating those events. For example, a lifetime's worth of experience can be compressed into a very short period of time in a simulator. An excellent illustration of this relationship between training and experience is the loss of an engine on takeoff. Very few pilots have or will ever actually experience one. Yet most professional pilots have developed the control skills necessary to safely fly an airplane through a takeoff following an engine failure at or above V^1.

The transfer of skills developed in training to an individual's experience file works. The proof lies in crew response to an actual failure. It is not unusual for a crew reporting on the loss of an engine on take-off to say, "the airplane flew just like the simulator." The key here is not that the airplane flew like the simulator, although that is surely the case, but rather that the pilot flew the airplane just like he flew the simulator. The transition from training to the experience file works. This is why training and experience are an important contributor to situational awareness.

Physical Flying Skills

Physical flying skills contribute to situational awareness. The role of the pilot is changing from that of a control manipulator to that of an information processor. However, it must be remembered that pilots still have to fly airplanes. Control skills are essential and contribute to situational awareness.

Spatial Orientation

This is knowing where the aircraft is in space and where you want it to go in relation to navigational aids, other aircraft, altitude, terrain, attitude, airports, runways.

Cockpit Management Skills

Cockpit management skills are the thread that binds this model together. We have identified ten specific skill areas that play a role in cockpit management and their effect on situational awareness. They are the vehicle by which a pilot can attain, maintain, and re-achieve (if lost) situational awareness. These skill areas will be addressed in more detail later in this paper.

Health and Attitude

Both contribute to situational awareness. Physical and emotional health affect an individual's ability to clearly see conditions and events and to interpret their meaning. Personal attitude also has an effect on safety. Safety does not just happen. One must work to make it happen. This equates to a sense of professionalism. Together, health and attitude are important contributors to situational awareness.

DYNAMICS OF SITUATIONAL AWARENESS

With this overview of what situational awareness is in place, it's worthwhile to examine its dynamics. The heart of this is a model of individual versus group situational awareness. A captain and a copilot can each have their own view of what is happening, each with his or her level of situational awareness. However, the key to safety lies within the cumulative effect of what these pilots know--that is, the group's level of situational awareness. Contrary to what one might expect, group situational awareness does not appear to be the sum total of the levels of situational awareness of the crew members. Instead, group situational awareness is limited to the level of situational awareness of the pilot-in-command.

Consider this illustration: a twin-engine jet with a two-pilot crew is in flight, straight and level at 250 knots. The aircraft is in the clouds, 500 feet below the peak of a mountain which is 2 miles ahead. The captain is flying the airplane. The aircraft and its crew and passengers are in a dangerous position.

The captain and copilot each have a sense of the situation--that is, a level of situational awareness. For the sake of this illustration, let us assume that the captain

does not know the mountain is dead-ahead. By the equation relating safety and situational awareness, the captain has low situational awareness. He is not safe.

In this example, the copilot knows exactly where the aircraft is in relation to the mountain. He can be said to have high situational awareness. By the equation, he should be safe.

What is going to happen to the aircraft? Clearly if the copilot cannot raise the captain's situational awareness, he will fly into the mountain. Despite the copilot's high situational awareness, the crew is unsafe.

This example illustrates how the captain can limit group situational awareness. A look at accident history provides a case in point. Just a few short years ago, a DC-8 ran out of fuel during a visual approach to Portland International Airport. The flight had experienced a gear problem. Concerned about the possibility of a post-crash fire, the captain elected to delay landing in order to burn-off as much fuel as possible. Too much fuel was burned. The aircraft lost power and crashed in a residential neighborhood short of the runway. Weather was not a factor.

During the events leading up to the accident, both the first officer and the flight engineer repeatedly expressed concern about the fuel-state of the aircraft to the captain. He did not heed their advice. The captain had low situational awareness. The other crewmembers had high situational awareness, and tried to raise the situational awareness of the captain. They were unable to do so. The aircraft crashed.

The B-737 that crashed on take-off from Washington National Airport in 1983 provides another example where a captain's low situational awareness could not be raised by other crewmembers, and the aircraft crashed.

Some of the cockpit management skills that come into play include communicating skills and managing people. These illustrations also draw attention to the concepts of command and leadership.

So far, this paper has examined situational awareness from several perspectives. The concept has been defined. The definition was expanded upon by identifying the five elements that contribute to situational awareness. Finally, the dynamics of situational awareness are described in the model of individual versus group situational awareness. The next step in this process is to put the idea of situational awareness into a practical format that a pilot can use.

THE ERROR CHAIN

The dynamics of situational awareness are embraced by the concept of the "error chain." It is rarely the case that accidents result from one clearly-defined catastrophic error. Instead, accidents tend to result from a series of errors or events. This so-called chain-of-events is called an error-chain. The cliche that "no chain is any stronger than its weakest link" might hold here. That is, if a pilot or a crew could be taught to break

one or more of the links in an error-chain, then in theory, the accident might not happen. This may appear to be too simplistic, however, after applying the concept to selected accidents, there is reason to believe that it works. In fact, by breaking only one of the links in an error-chain, it is possible to stop the progress of a flight towards an accident.

How then, may a pilot identify links in an error-chain so that the accident that might happen, is avoided? We have identified ten clues to the loss of situational awareness. They are the keys to finding the links in an error-chain.

1) *Ambiguity:* when two or more independent sources of information do not agree.

2) *Fixation or Preoccupation:* when attention of the crew is focused on one item, event or condition to the exclusion of all other activity in the cockpit.

3) *Empty Feeling or Confusion:* when a pilot or crew is unsure of the state of the aircraft or its condition.

4) *Violating Minimums:* when minimums are intentionally violated or consideration is given to doing so.

5) *Undocumented Procedures:* when consideration is given to using an undocumented procedure or when an undocumented procedure is, in fact, used.

6) *Nobody Flying the Aircraft*

7) *Nobody Looking Out the Window*

8) *Failure to Meet Targets:* when parameters or expectations of events are not met.

9) *Unresolved Discrepancies:* when confusion, questions, or statements of concern are not resolved.

10) *Departure from Standard Operating Procedure:* when standard operating procedure fails to be used at the appropriate time.

Any one of these can be a clue to finding a link in an error-chain.

This is not a black and white situation. Pilot judgement and experience is needed to put this to use. For example, while the clues are intended to identify lost situational

awareness, there are instances when they could result from high situational awareness. For example, it may be appropriate to use an undocumented procedure in the event of a failure for which no procedure has been developed.

The goal of training programs taught by FSI is to allow a crew to reach a higher level of situational awareness in the aircraft. Four of the five elements that contribute to situational awareness--experience/training, physical flying skills, spatial orientation, health and attitude--have traditionally been a part of professional aviation training programs.

The fifth element, cockpit management, has not been an integral part of training programs. It has been taught by exception, by instructors who orient briefings and training programs toward CRM type skills. Discussion of cockpit management skills has frequently been a part of "hangar flying."

In order to allow a crew to train to the highest level of situational awareness possible, it is necessary to have in place a training program that will allow them to focus attention on those areas that will contribute to that goal. The addition of cockpit management courseware allows this to happen.

COCKPIT MANAGEMENT TRAINING ELEMENTS

The cockpit management courseware used by Flight Safety addresses ten specific skill areas. Before reviewing them, it is first necessary to provide a reference point by establishing a definition of cockpit management. We define it as "the use and coordination of all resources available to the crew to achieve the established goal of safety, efficiency, and comfort of flight." The skills used to help achieve this goal are:

1) Checklist Use and Function
2) Management of Resources
3) Communication Skills
4) Recognition and Management of Distractions
5) Flight Planning and Progress Monitoring
6) Judgement and Decision-Making
7) Managing People (includes personality awareness, leadership and command)
8) Pattern Recognition
9) Stress Management
10) Workload Assessment and Time Management

This training is provided as part of a *Cockpit Management Concept* of training (CMC). There are four elements that make up the Cockpit Management Concept of training. The first is courseware for cockpit management training.

The second is Line-Oriented Flight Training (LOFT). The key to LOFT is the development of simulator scenarios that allow the crew to build experience identifying links of an error-chain. Teaching crews to find the links of an error-chain without the use of simulators and carefully designed LOFT scenarios is not likely to succeed. It has to be

trained into the experience file so that in the real world it can be turned into practice.

The third is crew self-critique. This involves the use of video cameras to record simulator sessions for use in debriefing. Our application is to permit crews to view portions of their own performance and to critique themselves. The learning potential is extraordinary.

The last element is instructor critique. Nothing works, in our view, without the instructor tying it together.

Each of these elements of CMC have been designed in a stand-alone or component format. That is, a student need not do all four in sequence to make the program work. Each section is designed so that it can be done independently of the other. They can be used in whole or in part. CMC training can be included in any training program. It can also be used as the format for a stand-alone course. This allows flexibility to meet various organizational needs. It also permits a course to be tailored to the specific needs of the student.

Flexibility is particularly important to us at Flight Safety because of the nature of our relationship with the crews we train. The pilots that we train do not work for Flight Safety. We work for them. This is different from the situation at most airlines and military training organizations.

Our cockpit management courseware is delivered by an instructor who then uses a specially-designed computer-interactive learning system to permit students to role-play, using the skills discussed by the instructor. As an option to instructor-led training or as a self-study vehicle, the interactive system can be used very effectively by itself.

We have chosen to include CRM training in four sections. One section of material will be taught at each subsequent training interval. The purpose of this sectional approach is to introduce this new material in a fashion that will allow it to be absorbed into a pilot's experience file, ready to be used effectively when needed.

For those who wish to address CRM training at one sitting, we will establish a three-day seminar late this year. Seminar training will be supported by LOFT training and crew self-critique during normal simulator training sessions.

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THE REGULATORY HORIZON

Ed Cook
Training and Technical Standards Division
Federal Aviation Administration

First of all, I want to thank NASA and the Military Airlift Command for inviting the FAA to participate. When I talked with Clay Foushee several days ago about the opportunity to be here, I mentioned to him at that time that we at Flight Standards feel that regardless of the history between the FAA and the airline community, and whatever problems may have or may not have existed before, we are all in this for the long-haul and we want to make the best of it on both sides.

Clay had asked me to keep the remarks as short as possible this morning to allow the opportunity for some questions and answers to take place. I explained to him that what I wanted to talk about very briefly were two areas. The first is cockpit resource management training as itself and what is on the regulatory horizon for it. That is very simple and straightforward in that we are neutral about cockpit resource management training at this point. I say that not being intimidated by what Lawson White said yesterday about good programs being screwed up by regulators. We don't know enough about the cockpit resource management training programs yet to be in a position to say anything about any regulatory activity.

However, I think it would be unfair if we were not to mention the fact that if a positive, good, safer air crew can be generated out of any training program, whether it is cockpit resource management or any other kind of training program, the question very probably could be asked of the FAA, which is the regulatory body: Why don't you require everyone to do that kind of training?

Right now, we don't have an answer to that. We don't know whether the question is going to be asked. And there are lots of questions, hopefully that the workshops this afternoon and tomorrow morning will be able to pull together for us.

The other thing that I wanted to touch on briefly is the cockpit resource management program as it is influenced by, and is part of, the current regulatory process for training and checking. It has been alluded to and was mentioned several times yesterday in connection with an exemption process that is currently underway with United Airlines. It allows United the option of performing their recurrent training on an annual basis for their flight crew members, which, as most of you know, is different from what the regulations require.

I don't know the specifics of the background of the exemption. My tenure in Washington has been rather brief so far. I understand, however, that that exemption was entered into some three-and-a-half or four years ago. And for those of you who do not know of the exemption process, an exemption is normally granted to a particular

request or for a particular set of reasons, normally for a finite period of time. Then this exemption can and often is extended, and at that time, with that extension, there may be additional requirements or modifications of the parameters of that exemption.

The current extension for the United exemption, I believe, runs out toward the end of this year. I believe it is the end of December. I am not sure now whether this is the second or the third iteration of the exemption extension process.

However, one of the problems that we--when I say "we," I mean the airline industry, particularly FAA Flight Standards and United Airlines--ran into was the kind of material that this kind of a program was going to provide to us. Basically, the reporting of data. The FAA was very interested in the program that was presented by United because, for the first time in a very long time, there was an opportunity to look at the training and how it was done, why it was done, where it was done, the tools that would be used to measure performance, et cetera.

The FAA hoped to gain some information about training and its processes with a view toward possible regulatory action in the future. The information that was supplied through the initial phases of the conduct of training at United under the provisions of this exemption really didn't give the kind of information that we had thought that it might. And without going into all of the iterations of the exemption extensions, we decided earlier in this year, and I believe it was in February, to outline some of the more specific questions that we needed answers to from United, that would allow us to extend the exemption should they wish to do so--fully believing they intended to extend the exemption.

We structured a letter and a series of questions to United that were rather detailed in nature. We also, in the body of the letter, I think, went into some detail to explain that we were not negative about what it was United was producing, or what it was trying to produce; but, quite the contrary, we were rather positive. We had a very strong feeling that what was being attempted at United was what we wanted to see or would provide information that would be very useful to us.

So, we were not trying to be negative about the program, or innovative thinking, or anything of the like. What has resulted from that process has been a very determined effort on the part of United to sit down with us on a periodic basis and discuss the answers to some of these questions.

There were two other petitioners who are asking for essentially the same kind of exemption authorization. And in fairness, we sent letters to both of those operators outlining essentially the same group of ten questions. We understand that there are other people also in the wings waiting to approach the FAA with the same kind of exemption request.

We don't know how well these kinds of things are going to be integrated into the existing regulatory process. That is the kind of information that we were asking from United and we would ask of anyone who would propose to participate in this kind of an exemption process.

Beyond that, I really can't say much about the regulatory horizon or the regulatory future of cockpit resource management. We don't know enough. Mr. White's review of the survey that he conducted of people who were participating in the program or in a similar program, I think, are indicative of that kind of information. There are very dispersed kinds of information available. The tools for measuring success in cockpit resource management have not been developed, or not developed extensively at any rate, so we are anxiously awaiting what the future is going to bring.

In Clay's (Foushee) opening remarks yesterday in the working groups, he posed the question whether or not the regulations might weigh heavily and be an obstacle in the way of developing cockpit resource management training. We certainly don't want to be a hindrance to any kind of development in a training area that would produce a better and therefore a safer crew.

I don't know that I can go into any more detail than that. If anyone does have any questions about what it is that we have talked about or the reasons we say what we say, I'd be happy to attempt to answer those questions.

DISCUSSION

CAPT. BEACH: I am curious. Off the top of your head, given the climate you are describing just now, does it seem to you that the FAA will be more responsive to individual entities who want to try something different, something that is now outside the current regulation?

MR. COOK: You don't ask easy ones, do you, Bert. I would like to think that the environment is continually moving forward. The dynamics of the industry are such that we are not going to be able to move very far, very quickly, with blinders on. I think that any kind of an innovative concept is something that should be evaluated as completely as its worth would indicate.

I guess the answer to your question in a word is "yes." I think the climate is more receptive now. However, any kind of thing that we get involved in in that area is definitely going to have to have some kind of supportive documentation that would allow us to do the kinds of things that we would like to do. When I say "we," I mean the industry as a whole. A warm "fuzzy," or a comment that the pilots like it, or that the crewmembers like it is not sufficient information to base any kind of regulatory change or any kind of authorization to deviate from the regulations. But, yes, I believe the climate is more receptive to innovative concepts--out of necessity.

CAPT. CAVANAGH: Are you able to share with us the questions that are being asked of United and the other two applicants?

MR. COOK: Yes, I could touch on them in broad scope. The people that I have talked with at United and with one of the other operators have indicated that some of the information and some of the areas that we have discussed they may consider to be proprietary. That may be overcautious on my part, I don't know--but I would rather not

go into too much detail out of sensitivity to those carriers for any kind of proprietary information that they may feel is theirs and that they could do something with on their own.

Briefly, the exemption that was issued was for the authority to conduct what has been known, now I guess generically, as single-visit training whereby they bring a crew in one time a year to do training rather than bringing each person in once a year for ground school, bringing the first officer or the second officer, as may be appropriate, in once a year for a proficiency check or a simulator course of training or a LOFT and then bringing the captain in twice a year, once for a proficiency check, and the opposite time for either a proficiency check, LOFT, or a simulator course of training.

The alternative in this single-visit option is to bring everybody in once a year. The question that we wanted to know was: Is there any program set up for measuring proficiency of a captain between months 7 and 12? And if there is not a measurement for those months, what reason can there be for not doing that? We do it now. Why should we not require that kind of measurement to be accomplished in months 7 through 12. And there may be a very valid answer for that.

What kind of a program exists or would be invented to identify line-flight incidents that would lead into some kind of trend which would lead into a training program modification? And what kind of information would be used to validate these trends, and the success or the lack of success of the training program?

What kind of a program would there be for the analysis of failed maneuvers or failed checks? And what kind of corrective actions would be taken and what kind of measuring devices would be used to improve the quality of the training program based on this analysis?

Why would the petitioner, or does the petitioner, feel that the best use of training time can be accomplished in the single-visit training versus the training that the regulations currently require?

There has been in the exemption process terms known as fixed and variable maneuvers. We were asking what would be the criteria for these fixed and variable maneuvers? What kind of criteria would be used to adjust the maneuvers from the fixed category to the variable category? What amount of time would be allocated? Would that have an effect on the overall program? And would this indicate a positive or a negative influence on the overall proficiency level of the crewmember concerned?

Another question area is basically: Is the crew concept for training and checking better than the existing regulatory requirements for crew training or individual training and checking? What kind of unique features of advanced simulation are incorporated into the training programs as a result of this program? Does the cockpit resource management program affect the proficiency level of the crew members and the overall safety of the operation? Is the exemption, or is this authorization, crucial to the conduct of cockpit resource management training and vice versa? And is the use of advanced simulation and advanced simulator training programs crucial to cockpit resource management?

In each of these questions or question areas--and there were more specific detailed questions in each of them--we were asking: What kind of data are you going to gather? How are you going to gather that data? How is it going to be validated to support the direction that you want to go with this training program?

As much as the answer to the question is important, the validity of the answer is equally important. Those are basically the areas of the questions that we are asking.

CAPT. R. BUTLER: As you know, we are one of the respondents to this questionnaire and we have already answered. I believe we have sent our answers in to Washington.

One question we have, and this is in regard to validation, and I think Dr. Helmreich briefly touched on it the other day, and that is the area of confidentiality. This is where we feel we have some major concerns because we are dealing with a pilot and a flight engineer work force--in fact two unions that are looking at confidentiality as one of the major roadblocks in terms of putting a validation program into place.

And I guess my question is: Is the FAA willing to address that and allow an independent agency such as NASA or a university do the validating work? Since we have included NASA-sponsored research at the University of Texas as one of the cornerstones in our original request for exemption, it's part of the request, so that makes it extremely important to us.

MR. COOK: In all fairness, I have not read the exemption request by Pan American. I do know that a letter with essentially the same body of questions was sent to the Pan American folks. I am aware that they have responded, and I think there is another letter about to go back.

As far as the willingness of the FAA to have other agencies participate in the validation process, definitely "yes." We are interested in providing an avenue that would result in the better-trained crewmember, and whatever that method can be is what we are interested in accomplishing.

There again, the validation is what is as critical as the answers to these questions are. Like I said earlier, the warm fuzzy kind of comments that you get from crewmembers, where they say, "Yes, we like it," and "we are doing better," and "it's well-accepted" are nice, but that is not sufficient to change the regulatory process for flight crew from individual training and checking.

MR. KREY: You mentioned fixed and variable maneuvers. Can you tell us what those are or what the concept is?

MR. COOK: I could only make a stab at that. That is one of the question we wanted to have some specific answers to from the people who were requesting the exemption. And if I garbage this up, folks, I hope you'll help me out here with the correct definition.

There is an attempt to define some of the maneuvers and procedures as fixed that are maneuvers that would not normally be seen in typical line flight operations--that are of a critical nature as far as handling an aircraft in a certain set of circumstances--

"engines out" and those sorts of things.

There are other variable maneuvers that may be appropriate for either an aircraft type or crewmember position or a location that might be appropriate.

These kinds of things are very interesting to the Flight Standards people in Washington, and what we were asking the petitioners for was a more accurate definition of the fixed and variable maneuvers, what the criteria would be for classifying a particular maneuver, either fixed or variable, how it would be changed, what the criteria would be for adding maneuvers or dropping maneuvers, what they would do with the time-frame involved from the typical proficiency check or simulator course that currently exists.

I don't know whether that completely answers your question, but I think that is the best I can do with it.

CAPT. R. BUTLER: In going back to a statement you had made earlier about the FAA not being negative, I do have to read a comment that we had from the original attitude survey that was sent to Dr. Helmreich on crewmembe attitudes. I'm not trying to be negative, but I would just like to give you the airman's perception. This is a first officer, and it says: "If cockpit resource management was presented the same as the FAA-mandated security training, it would be a complete and total waste of time."

And I have to pass that along to you because I think it does represent some of the fears of this body. I am not trying to take a negative position, but I am trying to reinforce what was said about the concept of regulation. I think we all have to be very careful because it is a new concept, and I think we jumped into security training, which has affected all of us in the airline business both economically, time-wise, and logistically.

So, I think any regulation in the future should be looked at very carefully and with a very close eye that we don't create this type of response to it from the airmen that do get the training.

CAPT. J. E. CARROLL: I applaud the fact, as Roy (Butler) has indicated, that there is no intent right now to jump into a regulatory mode on this because no one knows enough about it as yet.

I do have a question, however. Before that, I would like to give a little explanation from the standpoint of United and the exemption process with the FAA. When Walt Luffsey was there--at the time when we requested the exemption--there were four requirements as basic requirements before you could even entertain the consideration of an exemption.

One: You had to have the crew concept approach to training, which Ed has covered.

Two: You had to be using LOFT in an acceptable fashion within your training mode.

Three: You had to have advanced simulation equipment to use.

Four: You had to have a human factors ingredient within the training to even be in the position to request the exemption.

So, that was the rather generic basis of it. I didn't want the impression to be that it was strictly cockpit resource management which was the thing that was the key, if you will, perhaps at the time, because we had the other three. But it wasn't the only thing we had to have.

My question--as I say, I am glad to hear that it's not regulation as yet or even being considered--but there was a letter from the NTSB in April of last year that was sent to the FAA with two safety recommendations, one on wind shear and one on resource management. And as I remember the recommendation, the resource management recommendation was that you should research what was out there and available, and then consider making it a regulatory requirement.

From the standpoint of research, are you taking any steps, do you envision any approach that you're going to have to establish that research to obviate the concern that Roy and the rest of us have about jumping in too quickly?

MR. COOK: As far as any specific kind of research that the FAA is engaged in, I am not aware of anything specific other than the eagerness of the Flight Standards Division to stay abreast of what the current community of thinking is in cockpit resource management.

We are making some anticipated changes in not only the structure of flight standards, but also some of the personnel that are involved in the Washington process. The specifics for the personel part of that--we are currently looking at the option of acquiring the services of a dedicated educational professional, not FAA, to assist us in looking at training programs and the requirements for those programs and how they can best be instituted.

The possible structural change is a project that is currently ongoing in Flight Standards called Project SAFE. It's an acronym and I am not even sure now what S-A-F-E stands for.

It was a direct outgrowth of Secretary Dole's (Department of Transportation) direction of the implementation of the national air transport inspection that was conducted some time back. This project SAFE has been billed as the blueprint for restructuring Flight Standards. When I say "restructuring," I am not sure whether that is going to mean, as I said earlier today, a change on the door or a new building. And it may mean significant changes in some areas and not very significant changes in other areas. But those are two of the things we are looking at as far as trying to stay as abreast as we can of what the current situation--the philosophies, policies, and the environment is in all aspects--not only in cockpit resource management.

CAPT. CAVANAGH: Going back a little bit in history, before Ed Carroll and I were retired, this exemption process was first started about that time.

I can talk a little bit about the history of the variable and fixed maneuvers. They are independent of the CRM aspects. They are also independent of LOFT and the once-a-year visit.

As I understand and recall it, the FAA was interested in some experimentation and research in why we did the maneuvers that were done traditionally and regulatory-wise on proficiency checks that are covered in Part 121 of Appendix F that had been the same for a good many years. And they introduced the subject to United of incorporating this as part of the exemption. It was received favorably. I can appreciate now why they would want to have additional information on it. But, at any rate it was an attempt to identify better some of the maneuvers that might be more germane to operations today than those that had been used in the past.

MR. COOK: Thank you for the clarification.

PROF. HACKMAN: This is a friendly question. Sometimes the FAA is in a position of having to make a determination or move towards some policy on the basis of less than totally wonderful evidence--relying instead on inferences from fuzzier data or on expert judgment and so forth. The "Age 60" rule comes to mind as an instance when it is not really possible to tie things down, and you have to come to some kind of an arbitrary determination.

Having had a chance to look over the questions here regarding exemptions, it seems as if you're looking for some pretty well nailed-down evidence as regards making these exemptions. I was genuinely interested in what the circumstances are under which you'd be willing to go with inferences and expert judgments and things like that in making a determination versus when you really want to have it validated and all the "i's" dotted and the "t's" crossed.

MR. COOK: I understand. One of the things that we would like to be able to have, naturally, is just reams and reams of definitive, hard, cold, factual data to support anything that we would say. But we are not naive enough to believe that we are going to get anything close to that. And instead, we are anticipating that there are going to be areas where the best documentary evidence would be very highly subjective. And if we can have enough information that demonstrates that objective, hard, cold facts are just not possible--and the reasons for that--and enough documentation, if that is the correct terminology, for what high-quality subjective data is available, then that is our best evidence, and we will use that to make the determinations.

MAJ. AUFDERHEIDE: Thank you, Ed. With those issues in mind, we are going to break into working groups. Clay Foushee would like to talk about the instructions for the working groups.

EDITORS' NOTE: Subsequent to the workshop, a number of individuals have inquired about the possibility of obtaining a copy of the letter from the FAA to several air carriers requesting specific data prior to approval of an exemption allowing annual recurrent training for all crewmembers in place of biannual recurrent training for captains. This exemption has been utilized by at least one major carrier to expand their CRM training. Mr. Cook supplied the text of the letter which follows:

The Federal Aviation Administration (FAA) recently took a first step in a cooperative venture with the airline industry to explore new thoughts and ideas in the area of flight crewmember training. This first-step effort was entered into as a grant of exemption from portions of the FAR regarding the accomplishment of recurrent ground and flight training requirements as well as proficiency and line checks. It was conceived as an operational test of new training concepts which would maximize the benefits of advanced simulation and deal with the increasing complexity of cockpit human factors. This type of program has recently been referred to as "single visit" training.

A great part of the motivation of the FAA in allowing sufficient flexibility to accomplish this type of program was an opportunity to gather sufficient data on flight crewmember training concepts directly from the airline community to provide a sound basis for approaching future rulemaking, while at the same time providing data to support the contention that such a program was, indeed, a better way to train and check.

Because of the strong belief in the potentials of new and innovative concepts in the training and evaluation functions within the airline industry, the posture of the FAA regarding the acceptability of these new concepts remains keenly positive. It is for this reason that the FAA has encouraged this type of thinking and provided the flexibility to initiate trial programs in this area and fully intends to continue doing so when appropriate. However, any authorization to deviate or any grant of exemption from the prescribed FAR must have the assurance, as a prerequisite when possible, but at least collaterally, when necessary, that the proposed program will provide the intended results. This assurance must necessarily include specific empirical and/or other data that will prove the following:

1) the viability and efficiency of the program as meeting or, hopefully, exceeding the existing standards; and

2) provide at least a commensurate level of safety in the program's accomplishment.

This information will be used to evaluate any petition for exemption from the FAR in this area. Failure to initially provide this necessary and verifiable assurance will result in a denial of such a program, and failure to continue to provide this information, either as collateral requirements or as a condition of the exemption, will result in a rescission of approval for such a program.

To help prevent any misunderstandings, the FAA has generated nine question blocks, the answers to which, or a description of the methods that will be used to obtain the answers, will be used to evaluate the viability and efficacy of any proposed program of this nature.

QUESTION BLOCKS

Question 1: Will there be a method to measure the overall and specific proficiency in normal, abnormal, and emergency procedures and maneuvers of pilots-in-command in months 7 through 12 after completion of a proficiency check? If not, what data will be used to support the absence of such a measurement?

Question 2: Will there be a program to identify and analyze line flight incidents? If not, what is the reason for not having such a program? If so, how will these incidents be translated into trends and will these trends be incorporated into the training program? How will this success be measured?

Question 3: Will there be a program to analyze failed maneuvers or failed checks? If

not, what is the reason for not having such a program? If so, what action will be taken on the basis of the results of this analysis? How will you measure the success or lack of success of incorporating these results into the training program?

Question 4: What analysis was made to determine that the best use of training would result in the proposed application, as opposed to that as required in the FAR? What data has been collected that supports this determination?

Question 5: Will you propose defining maneuvers as "variable" vs. "fixed"? How will this maneuver designation and accomplishment affect the training program? How has this conclusion been reached?

Question 6: Do you propose that training and checking under a crew concept will be more effective than individual training and checking? What data have you collected to support this position? Should this program of training and checking be implemented, what data will be collected to verify its efficacy? How will these statistics be gathered?

Question 7: Describe any/all unique features of advanced simulation that will be incorporated into your training program that are not incorporated in the program currently. How will this modification affect your training program? How will the effect of this modification be measured?

Question 8: Will you include a training program for Command, Leadership, and Resource Management? If not, please explain why. If so, do you expect this program to affect the proficiency level of the individual crew member or of the crew as a whole? What data do you expect to obtain to validate this position?

Question 9: Is the Advanced Simulation Program and/or use of advanced simulators crucial to your proposal? What data is used to reach this determination and how has it been validated?

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INSTRUCTIONS TO WORKING GROUPS

Dr. H. Clayton Foushee, Workshop Co-Chair
NASA-Ames Research Center

INTRODUCTION

The p[illegible] objective of the NASA/MAC Workshop on Cockpit Resource Management [illegible]aining is to review the progress made in this area over the last several years and to determine what we are doing well and what could be improved. This task should be viewed as a critical review of CRM Training, and the product of these working groups should be guidelines that represent the training world's collective judgement regarding optimal use of CRM training. The key to the success of this workshop is your active participation in the working group process (see the Working Group Assignments sheet to determine your specific working group).

Each of the presentations in the general session was selected to provide you with the tools you need--ideas, concepts, and approaches--to undertake your working group tasks. It is the application of these tools, coupled with your training insights, that will produce these important guidelines.

Because of the critical importance of the working group concept, we have given careful consideration to developing workable, productive objectives and approaches for the groups, and to optimizing their structure and composition. The information below was assembled to assist the working group chairmen, vice-chairmen, and individual group members in organizing their efforts in each of the assigned topic areas.

OBJECTIVES

The goals of this workshop are to address four major questions regarding CRM Training. To some extent the working group topic areas parallel these issues, but in some cases they do not. However, it is important for all of the working groups to keep these general questions in mind during their deliberations:

- o What are the essential elements of an optimal CRM Training program?
- o What are the strengths and weaknesses of current approaches to CRM Training?
- o How can CRM Training best be implemented, and what barriers exist?
- o Is CRM Training effective, do we know, and if not, how can we find out?

TOPIC AREAS

Due to the size of this workshop, you have been divided into ten working groups in six topic areas. The topic areas and general information to be considered in each are presented below. The items proposed for consideration in each topic area are merely suggestions and should not be viewed as the only appropriate issues for your deliberations.

Topic I: Curriculum Development

In this area, we are asking the working groups to generate guidelines for an optimum syllabus to be used in CRM Training. In other words, if you were a course designer asked to construct such a training program from the ground up, what would you identify as essential elements of the curriculum? There are many ways to go about this task. One useful approach would be to identify those elements that are absolutely essential to maximally effective CRM Training. You might also consider prioritizing elements of your curriculum in order to identify those elements that are most important. Examples of currently utilized subject matter in CRM courses are: incident and accident case studies, theories of leadership, theories of group performance, leader-subordinate roles, resource utilization, interpersonal behavior, the relative importance of technical and interpersonal competence, etc. You have no doubt heard many more from the presentations. It is obviously important to decide *what* to train before you can decide *how* to train it. Most of you are aware of the diversity of opinion surrounding what CRM Training really consists of, and the guidelines produced in this topic area will hopefully produce some level of consensus on the "what" of CRM Training. Critique of current approaches should be an important element of these deliberations. In summary, groups in this area are asked to determine the essential knowledge and skill requirements for CRM Training and to generate guidelines for syllabus development.

Topic II: Techniques for CRM Training

The task of working groups in this area is to produce guidelines on the "how" of CRM Training. Once a course designer has identified a syllabus of essential elements, it is important that the most effective *techniques* be identified for getting the message across and producing the desired training effect. The relative effectiveness of various training techniques is a vital area of concern. It is generally accepted that some techniques are more effective than others for achieving maximum training impact. For example, presenting categories of desirable and undesirable behavior in a classroom context may not have the same impact on a trainee as an exercise in which the trainee views examples of his or her own behavior. The goal of groups in this topic area is to produce guidelines for the appropriate balance between techniques that supply information and a common conceptual framework, such as classroom instruction, and those techniques that supply "hands-on" experience to trainees regarding their own behavior when working with others in the cockpit. Techniques that are currently being utilized in CRM Training include: classroom instruction, group exercises such as role-playing, feedback on standardized interpersonal indices, group problem solving drills, videotape feedback, and LOFT. LOFT will probably figure heavily in your deliberations, since it is perhaps the most realistic of all CRM Training techniques. Critique of current

techniques should help with your deliberations. In summary, groups in this area should identify and evaluate techniques that can be utilized to train CRM and make recommendations for training techniques that should be incorporated in a comprehensive CRM program.

Topic III: Integration into the Total Training Curriculum

It has been said that for maximal effectiveness, CRM Training should not be viewed as a one-time course. This is because the production of tangible and lasting behavior change cannot be accomplished realistically in a short (two or three day) period of time. Thus, reinforcement of CRM concepts over the course of pilots' careers has been regarded as vitally important. This requires, to some extent, that CRM Training be integrated into the total training curriculum. Areas of consideration should probably include relationships to other types of training such as: initial, transition, upgrade, and recurrent. Remedial training for those individuals who are unresponsive to standard CRM Training has also been suggested as an avenue for exploration. Instructor training and quality control are also important areas for consideration. How often should this reinforcement take place? Do regulations governing training allow for optimum implementation and integration of CRM into other aspects of aircrew training? The product of your deliberations should be a report that deals with these areas (as well as others you deem appropriate) and would provide a training manager with a strategy for implementing a comprehensive program of CRM Training into all aspects of aircrew training. In summary, the task of working groups in this topic area is to develop guidelines for the integration of CRM Training into other areas of the training curriculum.

Topic IV: The Effectiveness of CRM Training

There is a considerable amount of discussion regarding the effectiveness of CRM Training. Much of this discussion has revolved around two different types of evaluation. The first concerns the overall *effectiveness* of CRM Training. Is it working? How do we know? Should we undertake a formal research evaluation of this type of training? If so, how should we evaluate the effectiveness of the concept? The second type of evaluation question has typically been concerned with the *checking* process. An often heard question is whether or not we should apply the same standard to interpersonal competence (or those behaviors associated with effective team performance) as we now apply to technical proficiency in our checking process. Virtually all of proficiency testing is now oriented toward the maintenance of individual technical skills. This creates something of a paradox, because many now maintain that a sizable majority of performance problems relate to inadequate resource management skills. If this is true, it might seem reasonable to check for proficiency in these areas as well, but this raises a number of other questions. One problem is whether or not we have developed adequate tools for checking CRM skills. Another relates to whether we can require such standards of performance under current regulations governing training. What other barriers to the optimal usage of the CRM concept exist? It is the task of this working group to provide guidance in these areas. While not directly related to the construction or conduct of CRM Training programs, guidelines in this area will be important for developing future endeavors in this area. In summary, the task in this area is to develop recommendations and guidelines governing a determination of the effectiveness of CRM training and how

proficiency should be evaluated on related dimensions.

Topic V: CRM for Corporate and Regional Operations

It has been noted by numerous sources within the operational community that the development of a comprehensive program of CRM Training is more difficult for operators without large training departments. Traditionally, CRM Training has relied heavily on such techniques as LOFT, which utilizes high fidelity simulators that in many cases cost more than the aircraft operated by corporate and regional carriers. Moreover, the monetary and personnel resources of these operators is often limited. Despite these difficulties, the needs for CRM Training are no less great, and in many cases the problem areas are the same as they are for large operations. Much of CRM Training may not be heavily dependent upon high fidelity training devices, and a great deal of development work has occurred in the training community that might be utilized by organizations lacking the capability to develop their own programs from the ground up. The task of this working group is to consider the special needs of these types of operations. This group should consider the issues in topics #1-3 and develop recommendations for the development of CRM Training focusing on the special needs of smaller-scale operations. Most of your deliberations should focus on both curriculum development and techniques, but you should also consider the integration of CRM into a total training program. Since the task of this group is relevant to most of the other topic areas, please feel free to consult individuals in other working groups.

Topic VI: Military Applications of CRM

Most CRM Training concepts have been developed by civilian organizations. As a result, MAC, in particular, has relied heavily on some of these programs in researching their training needs. However, the military environment presents a number of unique challenges that should be addressed in CRM Training. These include the interaction of the military rank structure and the flight deck command structure which are often independent, officer-NCO relationships, tactical operations, and crew experience levels. The task of this working group is to develop recommendations that address specific military needs. You should consider the issues in topics #1-3 and develop recommendations for CRM Training that focuses on the special needs and characteristics of military operations. Much of your discussion will probably focus upon curriculum development and training techniques, but you should not neglect to consider the integration of CRM into the total training program. Since the task of this group is relevant to most of the other topic areas, please feel free to consult individuals in other working groups.

WORKING GROUP PROCEDURES

There are ten working groups in the six topic areas (two each in areas #1-4 and one each in areas #5 and #6), and each of the ten groups has an assigned chairman representing the operational community and a vice-chairman who will serve multiple functions, including resource person, technical and scientific advisor, and recording secretary. Specific operating procedures have been left to the discretion of working

group chairmen. Working group assignments were made by NASA and MAC on the basis of several considerations. In general, we have sought to represent different perspectives in all of the working groups. Since there will be a number of subject matter experts in attendance, you may want to seek the advice and counsel of individuals assigned to other groups. Please feel free to do so.

The times devoted to the working group process are meant to provide guidance only. The only requirement is that we will reconvene at 13:30 on May 8 for working group reports, and you need to be finished at that time. If for some reason your group needs more time, there is no reason why you cannot meet in the evening or earlier in the morning if you desire.

You will also notice that there are times scheduled for working group chair and vice-chair meetings. These chair meetings are for the purpose of coordination and information exchange. Since there are two working groups in most topic areas, we feel that it will be useful at various points for groups in the same area to exchange information. In addition, we are asking that one oral report in each topic area be delivered to the general session. How the oral reports are coordinated between groups in the same topic areas is left to the respective chairs' discretion. Again, the times are advisory and left to the discretion of various working group chairmen. It is, of course, possible that groups will generate widely divergent recommendations in their respective areas. In order to allow for this, we may decide to publish all of the nine working group reports in the proceedings of this workshop.

REPORT FORMAT

It is the responsibility of the vice-chairs to help the chairmen draft the written reports. The general format of these reports should contain an introduction, discussion, and recommendations. Each report should contain, to the extent that it is appropriate, the groups' opinions with respect to the four major objectives of the workshop: essential elements, strengths and weaknesses of current approaches, implementation, and effectiveness. if possible, your recommendations should be tied to the identification of essential elements and a critique of current approaches to CRM Training in your topic areas. (Topic # 4 may not be amenable to this approach.)

The length of the written reports is left largely to your discretion. However, it is difficult to envision being able to handle any of the topic areas in less than five pages, while ten or more pages will probably be difficult to generate in the time allotted. While we realize the time is limited and may preclude a full discussion of issues, there will be a further opportunity for workshop attendees to participate in the editing process prior to publication of the proceedings.

CRM CURRICULUM DEVELOPMENT
Working Groups I-A and I-B

Lt. Col. Conrad S. Biegalski, Chair (I-A)
Dr. Barbara G. Kanki, Vice-Chair (I-A)

Capt. Dave Shroyer (ret.), Chair (I-B)
Ms. Linda J. Connell, Vice-Chair (I-B)

INTRODUCTION

Working groups I-A and I-B (composed of 18 and 17 members respectively) represented both large and small commercial airlines as well as the military. There was also a wide range of expertise. Some members had many years of experience and others were just beginning to develop CRM programs. All were highly-interested, enthusiastic participants in the group process. The concepts of CRM were kept in mind and used extensively in the working group's effort to develop a CRM curriculum.

During initial organization efforts, the group determined that any program of CRM training would have to be individually tailored for a specific group of crewmembers for several reasons:

1) Economics and management decisions dictate the scope and extent of any program of training.

2) Differences in size and composition of the crew, type of aircraft and mission suggest that one program may not be best for all.

3) Philosophies, skills, and knowledge of the individual program developers would ultimately impose a certain degree of variability among programs.

With this in mind, we determined that it would be incorrect to excessively prioritize items of curricula. Instead, our goal was to develop and present to future course designers a summary of virtually all items of significant value. Each organization could then use this information to guide their individual course development. Techniques for presenting course material and ensuring that no important area goes untaught were not properly within the charter of this group.

Once this principle was fully understood, we used "brainstorming" techniques to rapidly identify a large number of topic areas, without evaluation with respect to applicability or attempt at definition of terms. From the substantial list generated, we began to define, sort, and arrange the items before us into major topic headings and subheadings. During this process, a natural organization developed which simplified the remainder of our task. The following outline designates the major areas of concern, and therefore, the major categories of topic entries.

A) Assumptions and preconditions of CRM

B) Essential curriculum elements/topic areas to teach

1) Concepts to be understood
2) Skills (tools) to be learned/internalized

C) Other recommendations for CRM training

It is interesting to note that there was virtually no final disagreement among group members with respect to items of curricula. Disagreements which developed initially were quickly put to rest when semantic differences were resolved. Some words were instantly clear to all members, while others only became valid after heated discussion in which their definitions were made clear. Further, there a was a distinct similarity between the results of groups IA and IB, with little disagreement over final results. (See the "Note" at the end of the paper.)

ASSUMPTIONS AND PRECONDITIONS FOR CRM

Before attempting to develop a program of CRM training, three major areas must be specifically and consciously dealt with on the part of both management and course developers:

- Global goals

- Awareness of "bad" vs. "good" cockpit performance

- Critical planning elements

Global goals are those which override all aspects of any flying operation. They are two-fold. First, all flying is conducted to satisfy the demands of management. These demands may be based on economic considerations, as in a commercial carrier, or may be totally mission-oriented, as in a combat situation for military flightcrews. Second, safety must be maximized via crew coordination and joint responsibility. These two goals are sometimes mutually supportive and sometimes in conflict. A correct balance is not always easy to maintain, nor is it always clear when one goal or the other is paramount. It is essential that global goals be defined and consciously identified; for they, and the conflicts they can present, are frequently at the root of operational problems.

Awareness of "good" vs. "bad" performances is also vital. "Bad" performances can be more easily identified than good, but "good" performance can be stressed through development of individual role-models. The concept of "good" performance is also vital to preservation of self-image. While one cannot desire improvement until the need for improvement is felt ("Why fix what ain't broke?"), positive aspectsmust be stressed in all training and course development. The NEED for synergistic interrelationships among crewmembers must be accepted by students before a desire to alter individual behavior

can be evoked. Finally, flightcrews must be trained to recognize the existence of recalcitrant or untrainable individuals. This can occasionally demand drastic action on the part of a crew or of management.

Programs of instruction can be tailored to take advantage of two methods of identification of undesirable behaviors and attitudes in order to improve individual contribution to the group effort and create synergy. Both can be effective in conclusively demonstrating to students that they have room for improvement. These are:

- self identification

- peer group identification

Finally, we felt that the following list should be considered as critical planning elements in any course of CRM training:

- Careful selection of instructors/facilitators. Instructors must be selected on the basis of motivation to instruct, instructional skills, and sensitivity to student needs to insure their greater effectiveness.

- Motivation of students.

- Justification of CRM, CRM concepts, and the training program itself.

- Management support. No course will be effective without the overt support of both top and middle management. (Note that "support" does not in any way mean that management should "direct" the training. Management control of this type would severely undermine the purpose of the course.)

Neither the concepts to be taught nor CRM as an active way of life can have credibility without careful consideration of each of the four elements above.

Finally, it was of great importance to our group that, in spite of the fact that negative behavior patterns must be identified, the atmosphere of training itself must be positive. For example, one may point out the potential danger that a passive crewmember poses and identify the kinds of behaviors that are "passive" so that individuals can perform their own assessment of self and others. However, the CRM leaders/facilitators should not project a negative or evaluative tone toward the participants themselves; instead they should take a positive stance by focusing on the skills and concepts conducive to individual improvement.

ESSENTIAL CURRICULUM ELEMENTS/TOPIC AREAS

These are broadly broken down into the two major areas: concepts to be understood, and skills in which to be trained. There was a consensus that there is great value in teaching "understanding" of certain topics which pertain to the interrelationships between crewmembers. It is of equal importance, however, to teach "skills." We felt that

more immediate results could be obtained by a curriculum which left students with "tools" which could be easily retained and subsequently "carried to the cockpit" for direct application to the problem at hand. While it is helpful to understand why people act in certain ways, or to understand how to produce certain effects, one cannot apply "understanding" as readily as one can apply a "tool."

Concepts to be Understood

Having made the conceptual distinction between understanding and skills, we then found it somewhat difficult to discuss each type in isolation. For example, if interpersonal skills were being taught, it is obvious that certain concepts or knowledge about interpersonal behavior and relationships would have to be understood for the skills to be meaningfully conveyed and applied. On the other hand, one can teach personality theories on an "understanding" level quite apart from training the ability to actually apply those theories in one's work.

Thus, the topics listed under "Understanding" are not intended to constitute a comprehensive list; nor are they intended to substitute for the conceptual learning which is an integral part of learning skills. They are, instead, the "language" and awareness that enable skills to be internalized and ultimately utilized in an operational environment. There is a definite and obvious overlap of both areas. Final emphasis, however, must fall upon skills. We must be in a position to teach CRM skills to our crewmembers in the same sense that a pilot learns the skills involved in flying an ILS approach. While theory about the ILS transmitter and how the beam is received by the aircraft equipment is a thing of beauty, it is of no importance whatever if the pilot being taught is unable to actually fly an ILS approach. The list of topics to *understand* follows:

1) A common language and/or glossary of terms

2) The concept of synergy

3) The need for individual improvement in CRM principles

4) Guidelines for continued self-improvement (continuation training)

5) Individual attitudes and behavior and how they affect the team effort

6) Complacency and its effect on team efforts to produce synergy

7) Fitness to fly: the concept that each individual is responsible to arrive at work "fit to fly" and the ramifications and refinements of this concept

8) The "shell", or "unchangeable environment"

9) Resources available: identification and utilization

10) Prioritization, identification, and assignment of priorities

11) Human components and behavioral characteristics: awareness of the human being as a composite of many complex characteristics, often not volitional or controllable in nature. Each crewmember must be aware of this fact and these characteristics in order to adjust his/her own actions and behavior to optimize results.

12) Interpersonal relationships and their effect on teamwork: The way in which crew members approach, or respond to each other has a critical effect on teambuilding and team results.

13) "Team required" vs. "non-team required" tasks: For example, if the copilot spills coffee on his foot, normally team effort is not required. If however, the copilot spills coffee on the master copy of the computer flight plan, partially destroying its legibility, team effort may be required to reconstruct vital data. Thus some problems "require" a synergistic solution while others may be solved through individual effort (though the individual solution may not be the optimum solution).

14) Identification of norms (i.e., tacitly accepted actions, procedures and expectations): Whether consistent or deviant with written policy, norms exert strong pressures upon individuals to conform.

15) Pilot judgment: Once all information is available to the pilot-in-command, the situation may be clear-cut or may require judgment. These "judgement calls" are the ones which are most likely to spark dissent, to produce initial "CRM backlash," and to have a negative effect on the team.

16) The statutory and regulatory position of the pilot in command (PIC) as team leader and commander: All decision-making must be done by or funneled through the PIC.

17) Ground rules: policies and procedures to be followed during the course of instruction, as well as subsequent operations--for example, management support for the program and concepts taught; management support for those who attempt to act in accordance with learned principles; and absence of evaluation or punitive action during the course and afterward in actual flight operations.

Skills (Tools) to be Learned/Internalized

When selecting topic areas representing the skills to be learned, the group distinguished seven major areas. We assigned a number of specific subtopics to each of these seven domains for guiding course developers in their efforts. Some subtopics overlap into one or more major headings which attests to the fact that many areas of CRM are closely intertwined. The seven major areas and their subtopics are:

1) Communication

   a) cultural influence
   b) barriers, e.g., rank, age, flight position, etc.
   c) assertiveness, polite but assertive
   d) participation, requirement for
   e) listening
   f) feedback
   g) legitimate avenue of dissent (instant and ex post facto)

2) Situation Awareness

   a) total awareness of surrounding environment
   b) reality vs. perception of reality
   c) fixation
   d) monitoring (constant, regular)
   e) incapacitation: partial/total, physical/mental/emotional

3) Problem-Solving/Decision-Making/Judgment

   a) conflict resolution
   b) review (in flight, ongoing, immediate)

4) Leadership/Followership

   a) team building
   b) managerial and supervisory skills: plan, organize, direct, control
   c) authority
   d) assertiveness
   e) barriers
   f) cultural influence
   g) roles
   h) professionalism
   i) credibility
   j) responsibility of all crewmembers
   k) time/workload management

5) Stress Management

   a) fitness to fly: mental and physical
   b) fatigue
   c) incapacitation in varying degrees

6) Critique (three basic types)

   a) pre-mission analysis and planning
   b) on-going review
   c) post-mission

7) Interpersonal Skills

   a) listening
   b) conflict resolution
   c) legitimate avenue of dissent

Communication. Specific skills associated with good communication practices include such items as polite assertiveness and participation, active listening, and feedback. In order to improve the communication channel, cultural influences must be taken into account as well as factors like rank, age, and flight position which can create barriers to communication in the cockpit situation. Polite assertiveness is a skill frequently ignored in communications training but vital to a healthy cockpit. A single hesitant attempt to communicate important data fails to discharge individual responsibility. A captain/aircraft commander may be open to communication but be temporarily unable to receive and comprehend. Information possessors must be aware of the importance of their information and have a strong feeling of self-value. Captains must constantly strive to emphasize this in their team-building efforts. The concept of "legitimate avenue of dissent" (which deserves further development) won instant approval from both groups as an important vehicle for "clearing the air", maintaining lines of communication, and maintaining self-image. The problem comes in attempting to define specific avenues or tools for dissent, both during in-flight problem-solving and after the flight.

Situation Awareness. Situational awareness refers to one's ability to accurately perceive and to keep mental note of all current crew activity that can affect mission accomplishment or safety of flight. It further extends to planning multiple emergency options for any adverse situation that could occur in the immediate future. Maintaining a state of being situationally aware is a complex process greatly motivated by the awareness that one's perception of reality, and reality itself, sometimes differ. This awareness promotes ongoing questioning, cross-checking, and refinement of one's perceptions. The avoidance of fixation by constant, conscious monitoring of the situation is involved.

In addition, the "situation" includes the human environment. The evaluation of self and others for partial or total incapacitation is vital but often overlooked. Incapacitation can be physical, or, in its more insidious form, purely mental or emotional. Awareness of how much can be expected from each team member on a continual basis is a topic area needing greater development, especially regarding actions to be taken when incapacitation is discovered.

Problem-Solving/Decision-Making/Judgment. These three topics are very broad and interrelate to a great extent with each other and with all the other domains. However, we may consider problem-solving as an overall cycle of events beginning with information input and ending with pilot judgment in making a final decision. During the phase in which information is requested and offered, many (possibly conflicting) points of view may be represented. Therefore, skills in resolving conflict are especially appropriate at this time. All decisions, as noted earlier, must come from the pilot-in-command. (Note that the use of the word "command" persists despite all attempts to change it.) The team will fail if command authority is not maintained. This is the responsibility of ALL crewmembers. The inflight, immediate post-decision review is likewise a vital concept for promoting good decision-making and is frequently overlooked in the cockpit.

Leadership/Followership. In this domain, there is clear recognition that the command role carries important differences in responsibility from non-command roles. For instance, although every crew member should be actively planning and managing his/her own workload with respect to time, the captain is responsible for supervising the overall management of the flight and this command authority with respect to decision-making must be acknowledged at all times. The authority structure also impacts upon team building since the person-in-command (more than any other crew member) has the power to encourage a positive atmosphere for team synergy as well as the power to depress or inhibit synergy development. Finally, the effectiveness of one's command authority cannot be assumed by position alone. One's credibility as a leader is built over time and must be accomplished through conscious effort. It is a significant contributing factor to accomplishment of global goals. On the other hand, every non-command crew member is responsible for actively contributing to the team effort, monitoring changes in the situation, and being assertive when necessary. With respect to upholding the command structure, there must be an attitude of professionalism in spite of the problems and barriers caused by cultural factors and differences in perspective due to differences in roles and task demands.

Stress Management. Stress creates a special kind of problem for a crew since its effects are often subtle and difficult to assess. Although any kind of emergency situation itself generates stress, there is also the stress (both physical and mental) that a crew member brings to the situation and which others may not be able to detect immediately. Nevertheless, due to fatigue, mental and emotional problems, etc., a crew member's overall fitness to fly may decline to the extent that other crewmembers should consider him/her as incapacitated. Skills related to stress management, however, refer not only to one's ability to perceive and accommodate to stress in others but primarily to anticipate, recognize and cope with one's own stress as well.

Critique. Skills of critique generally refer to the ability to analyze a plan of action whether future, current, or past. Since techniques for accomplishing critique vary according to the availability of time, resources, and information; three basic types of critique were distinguished: 1) pre-mission analysis and planning, 2) ongoing review as part of the in-flight problem-solving process, and 3) post-mission debriefing. Our group strongly believes that all three are not only of vital importance but often overlooked both in action and in courses of instruction. Each type of critique has two major elements which concern us: 1) remembering to perform the critique (see presentation of Lt. Col. Biegalski), and 2) structuring the critique itself. This latter area is one which the

group suggests for further research. Experience has shown unstructured/intuitive critiques to be only partially-effective at best.

Interpersonal Skills. Many interpersonal skills have already been considered in relation to other domains. For example, the topic entries--listening, conflict resolution, and legitimate avenue of dissent--were previously discussed as communication and problem-solving skills. However, these kinds of skills can also be considered as a separate curriculum heading since they represent all-purpose tools for relating to people in many situations. Similarly, the concepts underlying these skills are not endemic to any one particular domain. Instead they are general principles which can provide a basis for improving interpersonal relations as the need arises in numerous application settings.

OTHER RECOMMENDATIONS FOR CRM TRAINING

Finally, the Working Group identified several other aspects of CRM implementation which they felt to be very important even though they were not strictly topics of curriculum. These items somewhat overlap with the topics of Working Groups II (techniques) and Working Groups III (integration into total training program). However, they also have a special significance to curriculum issues. First, it was felt that CRM training could not be effectively administered without provisions for recurrent training or some means of reinforcing the concepts and skills taught. Similarly, it was felt that integration into the total training program was desirable since effectiveness would again be impaired if other training domains failed to support the CRM principles.

A second area of importance in CRM implementation concerned techniques of training. Many group members felt that many curriculum topics were most effectively trained by means of LOFT/MOST. Some topics simply require a high degree of actual involvement and experience. Accident case analysis was also considered of extreme importance, not only in heightening awareness of poor crew coordination behaviors but also in providing practice in the development of "critique" skills.

Finally, curriculum development could not be considered complete without a discussion of resource materials. While it was acknowledged that many excellent programs and resource materials exist, the need was felt for a current/updated bibliography so that these resources could be easily located. Moreover, there was complete agreement that there be increased dialogue among all CRM developers and more frequent conferences in order to review progress and work on new ideas.

NOTE: Groups I-A and I-B independently arrived at very similar approaches to the curriculum issues of CRM. Although group I-B relied more heavily on "brainstorming" and clarification of terminology as the means of isolating the important elements, the results comprising the essential curriculum elements/topic areas were nearly identical. Within the heading, *ASSUMPTIONS AND PRECONDITIONS FOR CRM,* Group I-B incorporated into their discussions many of the issues mentioned by group I-A (i.e., global goals, awareness of "bad" vs "good" cockpit performance, and critical planning elements).

However, it approached them with some differences in terminology and emphasis.

There was also agrreement on the stated goals for CRM. Accident prevention was the first goal and a more efficient operation was the second. Less emphasis was expressed concerning "bad" vs "good" performance by Group I-B. The need for synergistic interrelationships, individual and group feedback, and identification of unacceptable behavior counterbalanced with the establishment of standards or norms in a postitve, non-threatening atmopshere were repeatedly confirmed by both groups. Within the topic "critical planning elements," Group I-B also emphasized that the choice of instructor/facilitator was a top concern for the success of any CRM program. It also emphasized the commitment of the highest level of management as crucial for program credibility. Finally, Group I-B emphasized that no aspect of any CRM program is intended to undermine or reduce the captain's authority. Aside from these slight differences, Groups I-A and I-B generated almost identical lists of essential elements and of skills to be learned. This report is an incorporation of the two groups' efforts.

TECHNIQUES FOR CRM TRAINING
Working Group II-A

Capt. Tom Nunn, Chair
Capt. Harry W. Orlady (ret.), Vice-Chair

INTRODUCTION

This working group was asked to produce specific guidelines on the "how" of CRM training. It was asked to identify the most effective CRM teaching or instructional techniques and to produce guidelines for achieving the appropriate balance between techniques that supply information and a common conceptual framework, and those techniques that supply "hands on" experience to trainees regarding their own behavior when working with others in the cockpit.

We began with the individual group members describing the techniques that each had used in their own CRM programs including both the effectiveness of specific techniques and any problems encountered in their utilization. This resulted in considerable discussion and a list of CRM techniques presently being utilized. A particularly useful outcome of these preliminary discussions was recognition that there are three separate phases or stages in the development of most successful CRM programs and that the effectiveness of specific techniques can vary with the training phase in which they are being utilized. The three phases of CRM training are:

- Indoctrination or Motivation.

  This stage is weighted heavily toward individual instruction. The principal objective is to motivate the trainees and provide a conceptual framework for CRM--to get them off to a good start.

- Extension or Transmission of Knowledge.

  Here the objective is to achieve an understanding of CRM principles as defined in the CRM syllabus. While this can be done on an individual basis, it can also be accomplished efficiently and effectively in a group.

- Skill Acquisition and Retention.

  This is primarily a small group function. The final goal is to achieve lasting acquisition and/or enhancement of the required skills in all cockpit crew members.

Working group discussions also developed a group of basic principles that are important to effective CRM training, but independent of the characteristics of the organization doing the training, and equally important, essentially independent of its training resources. These basic principles are:

- o Pilot-group participation is essential.

- o Leaders/instructors must be line-credible.

- o It is important to establish and utilize CRM terms and principles that are familiar to the pilots and organic to the organization.

- o Techniques that work well in one "culture" may not work in all others. The availability of the personal skills and other resources required by some of the techniques is an obvious consideration. (Note: Culture is used here in its broadest sense and can range from organizations to political or geographical regions.)

- o Instructor training is critical. Instructors have additional learning needs and require special training to develop understanding and skills above and beyond the basic CRM syllabus.

- o In virtually all cases more than one technique can be used effectively in each program phase.

- o There is considerable confusion regarding the requirement for and the optimum utilization of simulators. As a general guideline:

  - High-fidelity simulators are NOT needed for "people" training, but for techniques like LOFT, can be useful.
  - Simulators are needed for equipment managing.
  - Simulators are needed for man-machine interface.
  - Simulators are needed for flight crew interface with other elements of the system.
  - Simulators with considerably less than "state of the art" fidelity can be used very effectively.

- o It is easy to confuse the "media" used (such as lectures, film strips, audio or video recordings, etc.) with the "techniques" used. In some cases, the dividing line is blurred and any distinction becomes rather arbitrary.

- o More than one kind of media can be effectively utilized in several of the techniques, and equally important, several techniques can effectively utilize the same media.

COCKPIT RESOURCE MANAGEMENT TECHNIQUES

The CRM techniques identified by the working group can be divided into two categories:

1. Basic techniques that are important in all aspects or phases of CRM training, and
2. Techniques that are particularly effective in specific phases of training.

While time did not permit full discussion of each technique, brief additional comments that reflect observations, and in some cases differing opinions, are included.

I. Basic techniques that are important in all CRM training phases:

- Pacing (or timing) of the presentation of training material.

  This involves both the amount of material that is presented and the time frame in which it is given. Variables are the phase of CRM training, the knowledge and experience of the trainees, and the specific techniques being utilized.

- Line-credible leader.

  This does not mean that the leader (instructor, lecturer, etc.) must be a line-qualified pilot, but it is essential that he/she be recognized by the trainee pilots as a subject expert and that the subject is relevant and important to line flight operations. Considerable success has been achieved by maximizing the use of line pilots in this role.

II. Techniques that are particularly effective in specific phases of training:

- Workshops or Seminars.

  Most working group members believe that seminars or workshops are more effective if they can be held at a location that is isolated from the normal home or work environment, particularly if it is the trainee's introduction to CRM. Obviously this is not always possible and several examples of successful seminars that were held in the regular training setting were given.

  - A multi-media approach can be very important in maintaining trainee interest, particularly during workshops or seminars lasting three or more days.

- Panels.

  Panels are effective and can include "expert" panels, participant panels, or a combination. They can be presented live or through such media as audio or video cassettes or in written material.

- Group Exercises.

  A wide variety of group excercises have been used and found to be particularly useful.

  - CRM knowledge can be taught in a group or on a one-to-one basis. CRM skill acquisition and retention needs an interactive medium and a group.

  - Seminars or Workshops. One airline uses up to 18 trainees for its seminars or workshops which are held in a private setting off the company premises. It then splits them up into smaller groups of 5 or 6 for the interactive training phases. Prior to the seminar trainees are also given a small amount of introductory material. The aim is to lay down a conceptual framework for resource management and to motivate the trainees.

  - Role-playing. Role-playing provided considerable discussion and some controversy perhaps because it must be used with care. Pre-indoctrination in CRM principles and a skillful line-credible leader are important. Role-playing has been very helpful when it has been successfully implemented.

    - Can be used in LOFT for subtle incapacitation training but must be very tightly scripted.

    - Some members believed that role-playing was "clearly not for everyone." Others reported considerable resistance when role-playing was used with captains only. One group found that "some of our objectives were so sensitive to some participants that case studies were more effective, especially if they were not cockpit based."

    - Can be very effective where roles are exchanged because it gives participants a different perspective of other cockpit roles.

    - Should be tightly structured and requires a trained leader. Role playing can be very effective for acquiring knowledge and interpersonal skills.

-- Very good training for new hires.

-- Can be used for personal evaluation on first day, and then on last day to observe behavioral changes.

-- Have to be very careful about the negative aspects of some roles.

- Video taping. Video taping of group exercises is important for maximum effectiveness of group exercises. Most participants seemed to feel it should always be used with a bulk eraser. While at least one airline gives the VCR cassette to the trainee because of its continued training potential, in another airline it is forbidden under an agreement with its pilots for fear of potential misuse.

o Personality/Attitude Inventory

- These tests are a good facilitator to ease into effective role-playing.

- Very important to make sure that trainees understand that you are not trying to change what sort of persons they are--but how they act.

- Goal is to achieve better self-understanding and better interpersonal relations. Interpersonal relationships are really the essence of CRM and many tests are available.

- An advantage of the SDI (Strength Deployment Inventory) and other similar tests is that they can help sensitize people to the way they react to others. Some airlines use SDI for new hires. They believe that it gets them off to a good start and provides a better understanding of themselves and of others.

- The Myers-Briggs Personality Test was found to be very effective by at least one organization which believed it gave better understanding than the SDI.

- Some psychological tests are in an entirely different category. They should be avoided because they must be administered by a clinical psychologist. A line-credible leader/instructor should be able to administer any test used.

- Feedback of Interpersonal Indices

  - This is related to the previous technique (Personality/Attitude Inventory). However, feedback of interpersonal indices involves evaluation by the Instructor/CRM leader and feedback in numerical form to the trainee during normal debriefing. The feedback can be used to improve monitoring effectiveness, to identify individual interpersonal styles, and in critique of both the performance of self and others.

  - The rationale for using this tehnique is that resource management skills like "communication" (and actually any other skills) can be measured and quantified. Amounts of the component parts of skills can be determined unit by unit. The profile generated in this way can be accompanied by discussion of alternative approaches to improve performance and achieve objectives. There are usually several possible alternatives. The precision with which problem areas can be identified permits equally precise application of appropriate corrective action. It enables communicators to develop a means for choosing the "right tool for the job." The analytic technique is called *behavioral analysis*. It requires a skilled leader or instructor, and has been found to be very effective in a wide range of airlines and aeronautical organizations.

- Situational Leadership

  - This technique (like SDI) utilizes a special inventory to stimulate thought on alternative styles of leadership. It stresses the importance of recognizing the characteristics and "readiness" (both job readiness and psychological readiness) of the followers (other team members) in order to develop the full potential of the team. A leadership style that is effective in one group may not be effective in another. Situational leadership recognizes the need for leaders to adapt to the needs, attributes, and readiness of the other individuals with whom the leader has to work effectively.

- Evaluation/Critique

  - Performed by the crew involved after a group session. Voice and video playbacks of their performance can be very effective facilitators.

- o Case Studies

    - There was a strong consensus that VCR scenarios of accidents and incidents can be well acted-out and are very effective.

    - Replays of actual cockpit voice recordings are particularly dramatic and effective. Unfortunately they are frequently available only to the airline that was involved in the accident or incident.

- o LOFT

    - Consensus that LOFT should be a major part of all CRM programs if it is at all possible.

    - Same general comments regarding video taping of LOFT exercises that were made while discussing role-playing, i.e., video taping is important for maximum effectiveness and most participants believed it should always be used with a bulk eraser. In contrast, at least one airline gives the VCR cassette to the trainee, has had no problems doing so, and believes that it is very helpful.

- o Tutoring

- o Structured peer-group pressure (CRM principles)

- o Home Study

- o Guided/Structured Observation

    - The technique is to introduce an element of the theoretical by means of an example--such as a video tape, lecture, etc.--that tells the trainee to look for similar things in the real world. For example, if you are interested in listening skills, trainees can be asked to look for misunderstandings because participants were not actively listening. Specific subjects can be introduced with lectures, tapes, or written material.

- o Individualized Pre-work

- o Classroom Instruction (including the teaching interview)

- Two advantages of CAI or CBI (computer-assisted or computer-based instruction) are that it can be performed at the individual's own rate and it is interactive with the trainee.

o Part-task Training

o Continuing Training

The CRM techniques that were discussed during the working group meeting and had been found to be particularly useful in specific phases or stages of training are listed in the following table.

TECHNIQUES	INTRODUCTION MOTIVATION	KNOWLEDGE TRANSMISSION	SKILL ACQUISITION
Workshop - Seminar	X	X	X
Panels		X	
Group Exercises	X	X	X
Feedback of Interpersonal Indices	X		X
Situational Leadership	X	X	X
Personal Attitude Inventory	X	X	
Evaluation (Critique)			X
Case Studies	X	X	X
LOFT			X
Role Playing		X	X
Tutoring		X	X
Structured Peer Pressure			X
Home Study	X	X	
Guided Observation	X	X	
Individualized Pre-work	X	X	
Classroom Instruction	X	X	
Part-task Training			X
Continuing Training		X	X

TECHNIQUES FOR CRM TRAINING
Working Group II-B

Wing Cdr. Cyril B. Adcock, Chair
Dr. Charles E. Billings, Vice-Chair

INTRODUCTION

Wing Cdr. Adcock opened the working group meeting with some introductory comments. He noted that training in CRM or any other area cannot be considered in isolation: that it forms part of a continuum of experience which incorporates initial (academic) training, practical training, continuation training and, though less directly, instructor training as well. Training in cockpit resource management has several purposes, among them:

- To import new information
- To encourage introspection
- To encourage interaction (communication skills)
- To promote self-criticism (debriefings, etc.)

It was pointed out that although the Group's task was to focus on training *techniques*, this could not be done entirely out of context; it would be necessary to make some assumptions about what was to be taught in order to discuss how it was to be taught.

PRE-COURSE MOTIVATION/EDUCATION

After some initial uncertainty, the group began to converge on the topic of initial motivation. Should initial motivation of aircrew who are to receive CRM training emphasize the negative (accidents due to deficient CRM skills) or the positive (a new tool to assist crew to do the job better)? It was agreed that pre-training publicity can alienate if improperly done. Group members were less certain whether a well-done pre-training campaign would positively motivate crews. The example of United, which focussed initially on senior and management staff to get a cadre of supporters who could "spread the word", was brought up.

These points emerged from a lengthy discussion with much excellent give-and-take:

- Initial (pre-training) publicity has two purposes:
  - Motivation

- Education

o The medium or media for this element of the CRM training program should be that or those which are best accepted by aircrew

- Where applicable, management and labor endorsement of the program must be evident from the outset

o Organized "word-of-mouth" using experienced and trusted senior people can be a potent technique

- A demonstration program for senior and check airmen and Master Executive Council (MEC) members is one way to accomplish this

o Aircrew must become *actively* involved prior to taking the training

- Dual purposes: motivate (for program awareness), educate (to provide a conceptual framework)

- The workbook approach has been successful in some training programs to date

The question of whether initial CRM training should be free-standing or attached to (or embedded in) an existing training program was raised but not answered.

INITIAL (FIRST-EXPOSURE) TRAINING

Initial training in CRM has two purposes: the *transfer of knowledge* regarding the concepts, and the *acquisition or enhancement of CRM skills*. Techniques employed by group members were discussed at some length. What emerged was not a list of techniques, but rather some level of agreement on certain principles that should be considered in selecting techniques. The group members had widely differing assets which could be devoted to CRM training. The philosophies of their organizations also varied widely. There began to emerge a consensus that a CRM training program will be most effective if it is tailored to the organization for which it is intended. CRM will also be better accepted and therefore more effective if it is developed as an organic part of organizational philosophy rather than being presented as a novel concept which has been grafted onto existing training programs.

Transfer of Knowledge

It became clear that those organizations with experience in CRM training had tended to decrease their use of lectures as they gained experience and had moved toward earlier, and more, group involvement even in the initial education or knowledge transfer process. These points were made:

o Transfer of knowledge aims to introduce

- a common frame-of-reference within the organization

- a common "lexicon"

  - This works best if cast within whatever management doctrine already exists and is familiar to the aircrew: i.e., if it is "culture-specific"

o Many techniques have been utilized

- Lectures are minimized as experience is gained

- Examples (Air Saudia video mentioned as example)

- Working groups (see comments below)

- Group role-playing (increased as experience is gained to maximize involvement in process)

o Choice depends in part on number being trained

- Emphasis on "small groups: 3-16"

  - but depends on program approach

o Role of group leader/facilitator is *critical*

- must be credible to trainees

- but must also have skills in this role--and guidance

- not necessarily professionals

- many felt these persons must be volunteers from within the aircrew population

Given that the group (rather than the individual) becomes the focus early in the CRM training process, a variety of teaching/learning techniques can be used for knowledge transfer/acquisition.

o Techniques known to be effective

- Case studies to establish dimensions of problem

- Introduction of concepts and "tools"

  - Structured problems
  - Lectures
  - Guided discussion

- Individual, then group, exercises to emphasize value of the group (e.g., group can do more than the individual to solve problems)

  - Evaluation of scenarios
  - "Trivial pursuit" exercises

o Technique (and materials) must be appropriate:

- to the "culture" of the organization

- to the environment (military/civil, etc.)

- to the aircraft and mission

- to other cultural factors

Other related issues were raised, but not answered explicitly:

o When should first CRM training be given?

- at beginning of "new-hire" training?

- after acquisition of technical skills?

o When should first LOFT/MOST training be given?

o Should LOFT/MOST experience be juxtaposed with "batting practice" (maneuver-oriented training)?

It was noted that one carrier (People Express) has chosen to implement its CRM training over a period of almost one year, an approach which is believed to be unique and which has much theoretical appeal.

Skill Acquisition/Enhancement

The question of techniques to be used for acquisition or enhancement of CRM skills provoked lively discussion. Techniques in use by members of the Group range from group exercises through the USAF group interaction approach ("three chairs and a plumber's plunger") to sophisticated LOFT/MOST scenarios in full-mission simulators. Again, the Group found it necessary to enunciate some principles before considering specific techniques.

o Three types of skills are necessary for effective and safe flight:

- manual or psychomotor skills

- systems management skills

- crew management skills

o Conventional flight training emphasizes part-task training first, followed by integration of the newly-learned skills in full-task practice.

o It seems reasonable to apply the same approach to CRM training

- skill acquisition in a part-task setting

- integration of the new skills in full-task practice

o The critical issue is aircrew attitude, but skills must be acquired in such a way that they transfer to the real world

The Group recognized that some crew members already possess considerable managerial skills. It was emphasized that whatever training is provided must build upon these, rather than providing any degree of negative reinforcement to those who have already learned effective techniques.

o For skill acquisition, a great variety of techniques can be used

- group exercises

- workshop seminars

- role-playing

- tutoring (may be especially useful in remedial role)

- structured peer pressure (group self-debriefing, etc.)

o There can be no plagiarism given the common goal; new programs should make full use of the experience and insights of others

o For skill integration, LOFT appears to be as effective a technique as has been developed to date

- Highest fidelity available

- Tight scripting

- Role of simulator instructor in LOFT realism

- Scenario fidelity vs. simulator fidelity (simulator shortcomings can be downplayed with proper choice of scenarios)

o Objective is to permit integration of all aspects of piloting and crew management skills in an operational setting

- Critical importance of debriefing session

- Single pan camera has been found adequate

- Use of video believed to be critical to effective debrief (USAF uses even for its rudimentary simulation sessions)

REINFORCEMENT OF CRM TRAINING ON THE LINE

Any CRM training program must incorporate effective training for evaluators, instructors, check airmen. A few instructors who do not understand the concepts can do much harm. Several organizations have used commercially-available generic courses to train an initial cadre; this cadre has then brought the program in-house. Evaluators, instructors and/or facilitators need specific tools in addition to those provided to aircrew.

It is necessary to keep in mind that while the check airmen can help to reinforce good CRM skills, the basic job of the check airman is not to instruct; it is to evaluate. The Group also agreed that judgement is *not* quantifiable and that no attempt should be made to quantify it lacking better tools than now exist. Nevertheless, a thorough understanding of the principles of CRM not only permits check airmen to make a more comprehensive assessment of performance deficiencies in the cockpit but also enables them to provide more constructive debriefings and reports.

RETENTION OF CRM SKILLS

Relatively little time was spent on this important area. The Group felt that LOFT can be usefully used to evaluate retention of CRM skills once acquired, and that development of remedial packages for use thereafter should be one aim of the training group. UAL has chosen to emphasize certain specific aspects of CRM each year in its follow-on training. This approach is useful in that it forces the development of training packages that are available for remedial work as needed. All agreed that an on-going program was important, though its depth would be conditional upon organizational resources.

Finally, there was a limited amount of discussion throughout the workshop sessions of the level of experience and skill of the aircrew in various operations. It was recognized that this level has been very high in the past, but that during the next decade much of that experience will be lost and must be replaced by more effective training of a large number of less-experienced, younger pilots. This represents at once an enormous challenge and a great opportunity to develop and reinforce optimal flying and management behavior.

DISCUSSION (Working Groups II A and B)*

CAPT. HENRY: Would you expand on the evaluation part of the process--the "critique"?

LT. COL. KORPER: That started initially as the use of the video tape playback from the simulator LOFT-type mission training, and was expanded to the more encompassing; in other words, critique of the crews by the facilitator, self-critiquing of the crews of themselves, and possibly evaluation of the crew's application of the principle.

CAPT. NUNN: We'll conclude now, if there are no additional questions, but I would like to give you at least one result of a CRM program. One of the participants, and we will leave the program unidentified, upon leaving the program said that he had really learned something new about management, and that was the way he would manage fuel in the flight-planning phase. He said, "When I flight plan now I am going to add 'x' pounds for engine start and taxi; 'x' pounds for flying from point A to point B; 'x' pounds for my 45 minutes reserve, and then add an additional 'x' pounds for CRM."

DR. FOUSHEE: If nothing else, I think that matrix [Working Group II-A report] is potentially valuable for a number of organizations. Just to have it laid out like that and have it broken down by the phases of training that need to be addressed is a useful contribution.

*EDITORS' NOTE: Working groups in the same topic areas were asked to deliver one oral report, although most submitted separate written reports that appear in these proceedings. However, the discussion following reports was stimulated by the combined oral group reports. In each case, these discussions appear after the Group B written report.

INTEGRATION INTO THE TOTAL TRAINING CURRICULUM
Working Group III-A

Capt. Berton E. Beach, Chair
Dr. Donald E. Hudson, Vice-Chair

INTRODUCTION

The professional pilot works in an increasingly complex environment composed of dynamic and interrelated technical and social systems. Flight safety has long been the pilot's primary responsibility and until recently was assumed to be the logical result of finely-tuned technical skills known as "airmanship." Mounting accident/incident data suggest that while superior airmanship is an essential component of the job, it is insufficient by itself to assure safety. Safe and efficient flight operations depend on coordinated teamwork by the entire flightcrew. This requirement for coordinated teamwork involves a process of Cockpit Resource Management (CRM) that mandates a mix of interpersonal, managerial, and technical expertise. In the six years since the 1979 NASA/Industry Workshop on CRM, there has been a veritable explosion of training programs in both the military and civilian aviation communities dealing with this subject. This current workshop is an attempt to consolidate the findings and answer the question: "Where do we go from here?" Specifically for group III-A, given that CRM training should not be viewed as a one-time effort what is the best method for integrating it into the total training curriculum? Our group felt that this central question could not be addressed in isolation. Accordingly, our discussion centered around a few basic considerations:

A) *What* are the essential elements of an effective CRM training program?

B) *How* might this curriculum best be taught (i.e. methods, devices)?

C) *When* would the instruction take place to maximize benefits?

D) *Who* should teach and how should they be chosen?

E) *Evaluation*. Including, what to do with the CRM "resistant" individual or crew?

F) *Barriers*. What are the barriers to implementation of the training program in both management and aircrew? Are there specific strategies that can be taken to overcome them?

RECOMMENDATIONS

Essential Elements. In considering the topic area to which our group was assigned, it quickly became apparent that, even with the many different flying organizations

represented, there was a consensus that quality CRM training would include instruction in at least the following critical elements for all crew positions:

1) Role Identification

2) Leadership/Followership

3) Group Problem Solving/Synergism

   a) Situational Awareness
   b) Planning
   c) Assertiveness
   d) Crisis/Stress Management

4) Communication Skills

Methods. Most group members felt that flight simulator exercises using LOFT was the most powerful tool in both initial teaching and reinforcement of CRM techniques but that, depending on the resources available to the carrier, other methods were effective as well. For example, one particular classroom scenario involving the following items is recommended:

An academic exercise with the following elements:

   a) small group guided discussion
   b) role playing
   c) situational review
   d) optional self-study

The key elements in this teaching scenario are "active participation" and peer appraisal. These two ingredients were felt to be the most powerful levers to change non-effective crew behavior patterns.

Integration. While tackling the main topic area of our group, there was initially much discussion and, frankly, some confusion about the definitions of the training terms initial, transition, upgrade, recurrent etc. Clearly, these terms mean one thing in military applications, another to a trunk carrier and something even different to a regional carrier. For simplicity, we separated training into "Initial" and "All Other." Initial, however defined by the organization involved, would be an aircrew members' first exposure to formal CRM training (indeed, the first training exposure of any kind within the company) and would ideally include the following:

Module 1 - Introduction to CRM

1) Pre-attendance flyer

   a) general principles of CRM
   b) why needed--should include company policy and attitude toward CRM
   c) general outline of the training--not just this session but during

airman's entire career with the carrier.

2) Small group academic exercise with the elements discussed earlier--again with the emphasis on peer appraisal, active participation and role playing.

3) LOFT or some form of simulator exercise as reinforcement, with a debrief centered on evaluation of good CRM techniques and their use by the individual *and* the crews.

The group felt strongly that Module 1 should be able to "stand alone" and be given as a separate entity. It should be given "at the earliest opportunity" for existing personnel, regardless of rank or seniority, and incorporated as an integral part of the first formal training exposure for "new hires." After completion of Module 1, further CRM work would fall under the category of "*all other*."

In addition, the consensus of the group was that this exposure should be thoroughly integrated into an ongoing program and be accomplished whenever the crewmember requires training for whatever reason (annual, upgrade, transition, etc.). In this manner, reinforcement of basic CRM principles learned in Module 1 could be done in a more comprehensive context. Ideally, each line check would include a CRM evaluation of each individual and the crew as a functional unit.

It is highly recommended that recurrent CRM training be undertaken a minimum of once per annum. A special case involves certain international carriers who take their pilots ab initio; for them CRM exposure would be integrated at the ground level.

Teaching the Teachers. In discussing the proper method of developing the necessary instructor pool within an organization, our group could not come to a general agreement; therefore, two alternatives will be reported. Both sub-groups felt that the people who will serve as instructors need in-depth training well exceeding what they are expected to teach. A sizable portion of our group felt that the people already serving as instructor/check airmen should be trained first and, if possible, be split into two groups: 1) more "academically oriented" individuals to teach initial CRM (Module 1), and 2) more "operationally oriented" individuals for recurrent CRM ("All Other").

An alternative version of instructor training to which our group subscribed was that the instructor pool should come from line pilots--especially for the recurrent parts of the curriculum. This was felt to lend credibility that might otherwise be absent due to differing labor/management perceptions.

Evaluation/Remedial CRM. What is the definition of failure in CRM? Our group could not adequately answer this question--primarily because of the diversity of programs and consequent lack of comparable data on acceptable CRM performance. In general, for anyone needing "remedial" training of any type, CRM training with peer evaluation should be considered as an adjunct. For crewmembers who demonstrate specific deficiencies in CRM skills, their exposure to CRM techniques should be increased in future training of all types. Hopefully, Topic Area IV of this conference should address the issue in a more comprehensive manner.

Barriers to Implementation. In many ways, this topic was the center of discussion over the two days. Implementing a comprehensive CRM training program requires overcoming many attitudinal barriers among both management and line pilots, particularly flight instructors. The group outlined the major questions that would be asked by the two groups and suggested ways in which they could be addressed.

A) *Management Barriers*

1) Should scarce resources (i.e., money, simulator time) be committed to CRM training?

a) Even a casual review of pilot-preventable accident/incident reports reveals a large percentage due to deficiencies in resource management. This translates into very expensive hull and people losses.

2) There is no *proven* effectiveness of CRM training.

a) There has been an insufficient amount of time since the inception of formal CRM training to expect a significant impact. Since crew coordination errors figure prominently in such a large percentage of accidents and CRM training is a potential way of reducing their occurrence, professionalism and safety dictate an attempt at a systematic response.

B) *Crew/Instructor Barrier*

1) This is another solution imposed from above, a panacea produced by psychologists outside the aviation community.

a) Emphasize that the instructors will be active *participants* in developing and presenting a scientific method to teach principles that they *already* have been imparting to crews in a different way. In this manner aircrew help not only their peers but future instructors and line pilots who will follow them in the organization.

SUMMARY

We have tried to address some of the major issues surrounding implementation of a comprehensive CRM program into a flying organization. Clearly, our recommendations are generic in nature, and as such may not be suited for operational use in a specific set of circumstances. This is a reflection of the tremendous diversity of the aviation community and the fact that the concept of CRM is still far from maturity on many levels. It can be anticipated that CRM training will change and improve as our collective experience with the issues addressed by this workshop increases. At present, at least in the U. S., the regulatory atmosphere can best be described as "neutral." This condition beckons flying organizations to establish their own programs without undue interference. Hopefully, this climate will continue in the foreseeable future. We believe that CRM training, in whatever form adopted by the aviation community, will be a key factor in increasing the quality and safety of air transportation around the world.

INTEGRATION INTO THE TOTAL TRAINING CURRICULUM
Working Group III-B

Capt. Roy E. Butler, Chair
William D. Reynard, Vice-Chair

INTRODUCTION

Opening remarks by Captain Butler outlined the basic purpose of the working group format and challenged the participants to identify the relevant issues early in the deliberations. The working group's guidance in approaching the issues and the solutions associated with the integration of CRM training into existing training programs was provided by the following comments and questions contained in the Workshop's Instructions to the Working Groups:

"It has been said that for maximal effectiveness, CRM training should not be viewed as a one-time course. This is because the production of tangible and lasting behavior change cannot be accomplished realistically in a short (two or three day) period of time. Thus, reinforcement of CRM concepts over the course of pilots' careers has been regarded as vitally important. This requires, to some extent, that CRM training be integrated into the total training curriculum. Areas of consideration should probably include relationships to other types of training such as: initial, transition, upgrade, and recurrent. Remedial training for those individuals who are unresponsive to standard CRM training has also been suggested as an avenue for exploration. Instructor training and quality control are also areas for consideration. How often should this reinforcement take place? Do regulations governing training allow for optimum implementation and integration of CRM into other aspects of aircrew training? The product of your deliberations should be a report that deals with these areas (as well as others you deem appropriate) and would provide a training manager with a strategy for implementing a comprehensive program of CRM training into all aspects of aircrew training. In summary, the task of the working groups in this topic area is to develop guidelines for the integration of CRM training into other areas of training curriculum."

IDENTIFICATION OF BASIC ISSUES

The working group initiated its general discussion with an attempt to identify some basic issues associated with fitting CRM training into an existing management and operational environment, not just the specific training environment. The main issues and points that were produced during this discussion were:

1) What is the *awareness level* within the company management and amongst the flight crews of the value and the need for CRM training? Do all parties to the effort, those who have to sanction it and pay for it, and those to whom it is focussed, understand the benefits and the costs associated with this

methodology?

2) Who are the appropriate *players* for the implementation of CRM training? Beyond the initial proposal and approval phase, how wide is the footprint of CRM training within the company structure? Cockpit crews are the obvious targets for CRM training, but should it also extend to cabin crews, support personnel, and even some levels of management? Is there a value to having some of the less obvious company personnel aware of why CRM training is being instituted, what it hopes to accomplish, and how it will touch their individual functions within the company structure?

3) What is the appropriate *environment* for CRM training? This is not just a simple question of where do you do the training, this issue also encompasses the sociological environment within the company, the training department, any associated professional or labor organization, as well as the actual physical complex of classrooms, simulators, off-site activities, and on-the-job-training.

4) Is the aviation industry *leading or following?* Is CRM really only the specific application, to our particular activity--aircraft operations--of basic management and leadership principles that have existed in other industries for a long time. Are we, in the aviation operational community, simply recognizing now that the aircraft cockpit and its associated support network are basically similar to other functional group structures in which well-established interactive management principles can be applied, only slightly modified, to meet the unique demands of an aircraft's operations?

5) What are the principal *barriers* to the effective implementation and integration of CRM training? Is "cost" the biggest obstacle, i.e., if management doesn't see the value of doing it, CRM training won't get funded; or is "acceptance" by the relevant players the major challenge? If the crews don't understand or like it, CRM training won't be effective even if management pours money all over it! Finally, do other, more subtle, barriers exist, such as a shortage of non-financial resources: training space, skilled instructors, schedule conflicts, etc.

6) Do *different jobs have different needs?* Is there a requirement to create different CRM training for captains versus first officers versus flight engineers? Are their respective functions so different as to require individually-tailored CRM training segments to fit into their existing training and operational environments?

DISCUSSION OF ISSUES

Following the initial identification of issues, it became apparent that this working group, if not the entire Workshop, had a definitional problem with the term Cockpit Resource Management (CRM). Strictly interpreted, the term was too restrictive; liberally interpreted, it became all things to all people and its borders became blurred.

Working Group 3-B elected to refer to that body of knowledge normally labeled CRM as "It." "It" is not just training in a particular concept or to a particular objective, "It" is an operational style, a way of life that exists before, during, and after the operation of the aircraft. "It" incorporates comprehensive orientation to, and training in, multiple aspects of human performance and resource management. It was generally agreed that the term Cockpit Resource Management should be abandoned in favor of some other term which incorporates better the expanded elements and uses of what was originally a specific methodology for the better utilization of resources, human and otherwise.

Effective integration of "It" into the existing training and operational environment requires a comprehensive examination of the "organizational shell" in which the parties to be affected reside. This examination is essential to the accurate identification of the best and most effective locations and methods for the integration of "It." This is simply an expansion of the notion that "It" goes beyond the cockpit or the cabin. "It" exists within the framework of the aircraft and other hardware, the organizational structure, and that organization's policies and attitudes. Any integration of "It" into that total shell must first recognize the existence of the shell and its various elements.

Planners must have the support, if not complete understanding, of the company management for initial and ongoing "It" training. Once the proper organizational perspective has been achieved, the integration of "It" requires the development of a strategy for the introduction of training elements for all the identified players at all stages of training. Of primary importance is the necessity to establish recognizable relevance to line operations. If either the policy-makers or the crews don't see and understand the relationship of "It" to the basic mission of the organization, the training (and the program) will fail. Acceptance by the policy-makers and the parties to be trained was viewed as the most significant of the barriers to the effective integration of "It." Even though funding and other resource needs may pose barriers, if acceptance of the concept is not achieved it will fail even if all the other barriers are overcome.

Effective integration also requires the establishment of a policy to facilitate the "flow" of "It" training into existing training efforts. Don't put "It" in a box for separate attention; it is part of all aspects of training and operations and must be treated as such by all parties. Existing training programs should not be significantly restructured to accommodate "It", rather the new training should be melded into the standard programs. "It" is not an element that is "in lieu of" another training program, "It" adds another dimension to existing programs. The overall training program may experience a slight change of emphasis, but not necessarily any change in basic training principles or concepts.

"It" should be regarded as simply an elementary part of the established information loop (i.e., a crewmember is just as capable of getting a valid signal from another crewmember as he or she is capable of getting a signal from an electromechanical device). Therefore, it can be integrated, with care, into procedural and systems training sessions as well as into the more conventional cockpit management sessions.

There was total agreement that "It" should be integrated into every phase of training. Upon introduction of the "It" concept into the organization, or upon recognition of the need to place greater emphasis on an existing "It" element in current

training, all identified participants should experience a one-time/Phase I introductory "It" session; this initial and inescapable introductory session will be followed periodically by additional exposures in all other types of training periods. Integration of "It" training must possess the flexibility to accommodate the variable objectives, resources, and user's definition of their perceived needs; and this flexibility must be reflected in the initial, as well as all subsequent, training exposures. The "bottom line" is that "It" training is to be created in such a way that it is consistent with all training; therefore, every time a crewmember is exposed to any training module, he or she gets "It" as an element of that training session.

One of the major points to come out of the workshop discussions is best characterized by the notion that the *manner* of incorporation of "It" is as important as the content of the training that is melded with the existing programs. In essence, the point to be made is to assure that in the process of introducing "It," that that activity does not manifest any negative influences on basic training activities.

The one-time introductory/Phase I exposure to "It" can be presented in any appropriate mode: classroom, take-home, simulation, etc. as determined by the training office. It can take place over any reasonable period of time, so long as it is identifiable as an introductory exposure. There should be no pass/fail requirement; however, if any participant seems to be having difficulty with the introductory lessons, provisions must be in place to detect such difficulty and remedy the problem before the whole effort gets distorted.

Provisions must be made for remedial "It" training. "It" is not going to come easy, or at all, for a percentage of the intended recipients. The shortcoming may manifest itself at any stage of the attempted training process and, whenever it does appear, the training program and schedule must be capable of focusing some additional attention on the individual or crews having difficulty with the concept. Keep in mind that "It" is being viewed increasingly as an operational style, not just as an isolated concept. Therefore when out on the line, even if "It" did not "take" with one out of three crewmembers, at least two of the three can take up the slack and cushion the impact of the failing member's actions and attitudes.

TRAINING THE TRAINER & QUALITY CONTROL

It is critical that those individuals selected as instructors in "It" training programs understand the underlying principles and objectives of the concept; furthermore, they must appreciate the importance of the training's results and they must understand the relationship of "It" to actual line operations. This will require an in-depth orientation in resource management for "It" instructors and a quality training program for instructional personnel. Every instructor that has an interface with "students" must know about, understand, and appreciate the value of "It" generally, and more importantly, they must recognize the specific value for each of their respective training segments and activities.

Instructor personnel with specific responsibility for "It" training should possess qualities that enhance the basic premise of resource management. Some of those

attributes would include: 1) professional competence, 2) shared experiences or a common background, 3) a spirit of volunteerism, and 4) a commitment to the principles of "It."

Quality control for "It" training is not that different from any other training program. The workshop participants identified the following points as instrumental in maintaining an effective quality control: 1) Periodic review by the designers of the program and the instructors; 2) Critique by the users of the training and materials (instructors & crews); 3) Direct observation of line operations to test for training effectiveness; 4) Instructor feedback from transition, recurrent, and upgrade students; 5) Team teaching; 6) Periodic reinforcement to instructional personnel of the value of "It"; and 7) Periodic reinforcement of management's familiarity and commitment to "It".

REGULATORY ROADBLOCK

One of the barriers to the effective integration of "It" into all phases of training is produced by FAA inspectors not permitting check airman to interact with flight crews during operational evaluations, thereby making it difficult or impossible to incorporate "It" into the check-ride phase. It has been argued that since the FAA only sets minimum standards of performance and training, room exists within the existing standards to incorporate "It" into all phases of training, including the check-ride. Most organizations already go beyond the minimums, and are strongly encouraged to do so by the FAA. To this end, training departments should invite FAA and other regulatory personnel to become acquainted with "It" programs and their integration into existing training. Regulatory personnel should be encouraged to participate in discussions regarding, and become a part of, the integration process. Principal Operations Inspectors and Air Carrier Inspectors, and their military equivalents, should be invited to take introductory and other periodic "It" training. Finally, it was generally felt that as "It" is integrated into normal training activities, and as FAA and regulatory personnel become more comfortable with the concept, the regulatory roadblocks will be overcome in favor of the perceived need to encourage communication and interaction. Integration of "It" will probably become a requirement once the regulatory agencies recognize the value of strengthing a crew's management skills, as well as their technical skills.

SUMMARY

The working group believes that "It" is an important new concept that is badly in need of precise definition. "It's" principles should be fully integrated into all phases of training and all phases of operations. "It" involves a major change of emphasis and operational style for crew members and all other players involved in the operation of today's aircraft. The implications of these changes go well beyond the confines of the cockpit and extend to all areas of the organization.

DISCUSSION (Working Groups III A and B)

CAPT. MALLORY: Roy (Butler), you mentioned that the trainer that will be training the other people would be outside, and be trained more in depth in leadership styles and that sort of thing. Could you expand on that a little bit? Would they teach the other pilots within the group? In other words, after those trainers have been trained by someone, then did I hear you correctly in that they, in turn, would train the other pilots of that group.

CAPT. BUTLER: That would be an option. The question was, after the initial trainers were trained by the prime mover, would they, in turn, train the trainers. And I think that that would probably be more an organizational decision. Because certainly you could train those trainers to train other trainers. And I think this is done, in fact it was our intention. The initial people, that were going to conduct the Cockpit Resource Management seminars would in turn become trainers of trainers. Of course, there would be nothing to say that the developer couldn't, in that sense, train everyone to do the training.

CAPT. EAMES: I have just retired from British Airways, and I spent my last 11 years there as a Concorde training captain.

I came to this workshop not knowing anything about CRM, and wanting to know. I have lots of question, and so there are lots of questions following. And I wonder how an airline like United finds that it needs a CRM program?

I was amazed to learn that during the course of this workshop that the Military Airlift Command think that they need Cockpit Resource Management training. And it's my view--and this has developed over these last three days--that CRM is being used on a symptom, and that it is not addressing the root-cause of the problems that these airlines and this Air Force have.

And we mentioned the other day somewhere that initial selection was important. And I don't think any of us would deny that. But where have the airlines and the military gone wrong. I think that it is in the area of initial training and recurrent training.

And if I can go back many years, I can recall as a cadet being instructed in a thing called "Airmanship." Maybe this is "it." It is my belief that airlines have ceased, or perhaps never included, airmanship in their recurrent training programs. Perhaps we instructors have been remiss, and failed in our duty. Maybe we've been dazzled by the new training tools that we have--the sophisticated simulators with realistic motion and visual systems. And maybe we have been inhibited by the need, every six months, to demonstrate basic flying skills.

Perhaps by insisting on standard operating procedures we are suppressing a crew member's "critical faculties." What we've succeeding in doing, in my view, is to produce good aircraft handlers, and what we have not produced is good airmen.

Whilst I don't deny the need for CRM training in specific cases, I don't subscribe to the view that it's a panacea. I think we need to look much farther back in the training cycle, starting with our basic flying schools or military flying academies and continuing through airline or squadron initial and recurrent training. If we'd done this in the past, would we all be here now?

CAPT. BUTLER: I'm not sure how much of that was a question, and I am not sure how best to answer it. However, I can answer at least part of it. Pan Am has not hired a pilot in 18 years. So we don't have the luxury of redesigning an initial training program in that respect. But we are looking at the initial hiring processes. In fact, under our CRM-LOFT umbrella we are probably going to include initial hiring and initial training because we feel that they are lumped together--that they are part of the same process.

And I would say that what you describe as "airmanship," I would describe as management in the cockpit. We have trained people to do the stick-and-rudder work, and we have trained them to use crew concept. And I think that--this not my area and I may be stepping on a few toes here--but I really feel that management for pilots has not been addressed.

And as I said, when you put a man into a 747--I think the price is now up to around one hundred twenty-five million for some of the later versions--you are giving him quite a resource to manage. I think that he needs some training in how to manage it. And I think that management is part of airmanship. I don't know whether that answers your question, because I don't think you gave me a question. I think you made a statement.

CAPT. EAMES: My point is that we should be doing this training from Day 1--when we get a man out of high school, or wherever, and start training him. This is where we should be doing it.

CAPT. BUTLER: I can't agree with you more. I think that that's what we would like to do. And I think this would be the ideal way. But we haven't done that with the ten thousand or so airmen that are around, and have been around, for some time now. We're trying to make up for what we didn't do when they got out of high school.

CAPT. EAMES: Yes, but what we're doing is addressing the symptom. What we need to do is to go back further in the course of instruction.

COL. BIANCUR: I agree that it is an airmanship sort of thing. We think in MAC that we've been training all along in what we've always referred to as "crew coordination." Now what's become different in the last series or several years? It's my contention that what's really changed is what Richard Hackman's talking about. The "shell" has changed quite a bit.

In our primary or our basic flying schools, its primarily single-seat responsibility. The first time that gentleman sees a crude airplane, if you will, other than having an instructor or a talking corrector in the back seat, is when he gets into the Military Airlift Command--into our initial training. And yes, when we place him in the right seat, we tend to begin to bring him into the crew concepts. There are other inputs to his data

bank, if you will, to assist him in decision-making.

Well what has happened in the last several years is, as we all know, that technology has made tremendous strides. What that's meant in the cockpit is that we're presenting the individual with more sources of data.

Unfortunately, at the same time man hasn't changed a whole lot since our forefathers first stepped around. We still have about the same size brain, and our reaction time is still about the same. We're asking him to take in an awful lot more information and at the same time, we're pulling people out of the cockpit to assist him. The basic hands-on, stick-and-rudder skills are requiring more clearly-focused attention. And because of what that does to today's pilot, he either denies or does not allow the input of the information that is available to him.

I think where we're coming from in MAC is that we are trying to work on the weak point within that environment. And that's the human. And how can we help that individual, or more accurately those individuals, manage their time to take advantage of the several more inputs that he has available to him? That's really what it is. I don't see CRM as anything other than another name for a dimension that we can call "airmanship." Whatever it is--we can call it "bananas" if we want, but what we want to do is refocus our attention. Not on the technology of stick-and-rudder, but on how to get today's pilots to accept this wider "shell"--or this variably-designed shell that Richard (Hackman) refers to.

DR. FOUSHEE: I think that's a great observation.

MR. ROGERS: As part of this point, think back to that chart that the United Airlines group put up that had the 1.97 per 100,000 passenger-mile rate back in 1950. That rate is down now to about .02, and we can't even afford that rate. Because when a B-747, or a DC-10, or a C-5A is involved in an accident, it involves a greater tragedy than back in 1954. So what we've done is we've brought the rate down, but now we've really got to focus on what are the causes of those accidents that remain.

THE EFFECTIVENESS OF CRM TRAINING
Working Group IV-A

Capt. J. E. Carroll (ret.), Chair
Dr. Alfred T. Lee, Vice-Chair

The objective of this working group was to address three major dimensions of CRM training. First, to determine the extent to which CRM training programs are effective and whether a formal evaluation of CRM training is needed. Secondly, to recommend guidelines for CRM proficiency assessment. Finally, to determine if any barriers to effective CRM training existed and, if so, to recommend methods by which they could be eliminated.

In order to reach these goals in the time allotted, the group focused its activities on answering five general questions which were formulated to guide the discussion. These five questions were as follows:

1) In general, what knowledge and skills form the basis of CRM?

2) To what extent are current programs effective in training CRM?

3) Is a formal evaluation of CRM training programs needed and, if so, what should such an evaluation encompass?

4) Should the same standards that are now applied to other areas of aircrew proficiency apply also to interpersonal skills? Are the tools available for measuring these skills adequate?

5) Do any barriers exist which might limit the effectiveness of CRM training? If so, what action is required to eliminate them?

CRM DEFINITION

The first of these five questions reflected the group's need to have a working definition of CRM before addressing the issue of training effectiveness. It was felt that CRM has not been well defined and that considerable time would be saved if general agreement could be reached at the outset as to what CRM entails. The group considered CRM to be an umbrella term for a constellation of knowledge and skills all of which comprise effective cockpit resource management. Key among these were considered to be: a) interpersonal communication both inside and outside the cockpit; b) leadership and task management, particularly task load assessment of crewmembers; c) decision-making skill; and d) information utilization, specifically the use of all available information sources including monitoring and cross-checking. While these areas subsume a variety of component skills, these are believed to be the predominant ones that CRM training is intended to address.

CURRENT CRM PROGRAM EFFECTIVENESS

While it was recognized that many operators, both civil and military, include some elements of CRM in conventional training programs, the group decided to concentrate only upon those programs formally designated as CRM training. Although detailed information was lacking on all CRM programs, it was believed that there was sufficient knowledge of CRM programs to allow at least a preliminary assessment. The group believed that there was sufficient evidence supporting the effectiveness of CRM to warrant its continuance in the training environment until a comprehensive evaluation could take place. This conclusion was based upon several types of evidence. First, the programs had a high degree of face validity. That is, they reflected sound operating principles and focused on areas of known weaknesses as supported by accident/incident data. Furthermore, the skills which are targeted for improvement in these programs and the means to achieve that improvement have been incorporated into effective programs already in use in other areas such as business management. Secondly, anecdotal evidence by pilots, training management, check airmen and others in the training community are generally positive with respect to the need for and the effectiveness of CRM programs. Third, the objective data, although very limited in scope, is encouraging. United Airlines, which has one of the more established and fully integrated programs in place, has reported improvements in training, checking, and hull loss figures.

FORMAL EVALUATION

The third question addressed concerned the need for a formal evaluation of CRM. The group dealt with this issue at three levels. First, individual crewmember assessment was deemed desirable in order to facilitate the training process. Non-punitive, constructive, and confidential feedback to the pilot concerning his/her CRM skills was deemed necessary for effective training. It was, however, strongly emphasized by the group members that, at this time, a formal evaluation or check of CRM skills was highly undesirable. Introducing a check-type environment where loss of certification was a possible outcome would have a strongly negative impact on the training of CRM skills since acceptance of the CRM training concept by both management and pilots is as yet preliminary. At a later time when CRM is fully accepted in the training environment and when measurement techniques are validated, such an evaluation could become possible.

The second level of formal evaluation of CRM is that of the organization's specific training program. At this level there was general agreement that an organization needs to conduct a formal evaluation of CRM and should incorporate the apparatus for evaluation as a part of the program. It was repeatedly stressed, however, that the evaluation must maintain strict confidentiality of crewmember performance data and that the goal of evaluating the program, not the individual, must be kept in mind. The purpose of such an evaluation is to assure that appropriate and timely modifications to the CRM program content can be made as the program evolves. An emphasis on flexibility is needed as CRM training elements must be tailored to individual organizational needs and, therefore, certain aspects of the training program will be

subject to change.

The third level of CRM evaluation considered by the group was that of the CRM *concept*. At this level, there was uniform agreement that a neutral organization (e.g., NASA) should conduct an overall evaluation of the CRM training concept. Such an evaluation should include measurements at both the macro (e.g., accident/incident records) and the micro (e.g., observations of crewmembers) levels. As a part of this evaluation a comprehensive data base should be established for the participant carriers which could serve the additional purpose of enabling them to monitor the progress of CRM and to permit further refinements to their CRM training program. This information could also be used by carriers wishing to evaluate future CRM training programs thus avoiding the cost and delays associated with establishing their own pre-CRM training database. As the goal of such research would be concept validation, a wide range of programs and operational environments should be included. The results of this research could be used to refine the scope and application of CRM training and to provide a comprehensive examination of the status of line crew CRM skills prior to and following CRM training.

PROFICIENCY STANDARDS

The question was then addressed as to whether the same standards that apply now to other areas of aircrew skill should apply to CRM. The group was unanimous in rejecting any attempt to apply these same standards to CRM at this time. One of the key problems in setting standards comparable to those now in use was the state-of-the-art with regard to crew measurement. It is particularly difficult to assess individual CRM skills in a crew context where other members' actions may have a deleterious effect on the behavior of an individual crewmember. Also, there are a number of ways in which good cockpit management can be exhibited and this may further compound the problem of measurement. Further development and validation of CRM performance measures are needed before any meaningful standards can be developed.

Not only the capability of CRM skills measurement was questioned but also the desirability of such measurement in light of the degree of acceptancy and understanding of the goals of today's CRM programs. The need still exists to sell CRM on a supportive basis to the industry, and invoking standards action at this time would hinder that process. Once CRM is an accepted concept industry-wide and adequate tools are available for measuring it, then proficiency standards could be introduced.

BARRIERS TO EFFECTIVE CRM TRAINING

In general, the group concluded that two potential barriers to effective CRM training exist. The first major barrier to effective CRM is the organization. All organizations have a tendency to resist change, and even after accepting the concept, CRM programs may be limited to brief, one-time trials with inadequately trained personnel in an effort to keep costs to a minimum. Moreover, all new ideas are

inherently suspect since they imply that old practices were less than adequate. To overcome organizational barriers, the group emphasized the need for education of management on the importance of CRM to safety and of the potential cost savings of such a program by reducing accident rates. It was also recommended that CRM be integrated into the overall training program not only to improve effectiveness, but also to avoid identifying CRM as a separate trial program which could be highly vulnerable to operating budget reductions. Finally, the group recommended the CRM concept definition should be refined and standardized so that management has a clearer understanding of what CRM is, and what it is not.

The second major barrier to effectiveness was pilot resistance to CRM. There is an inherent threat to a pilot's self-image from new training programs purporting to improve skill and a threat that such programs could introduce one more set of proficiency checks that jeopardize a flying career. There also exists the possibility that captains will view CRM training as a threat to their authority in the cockpit.

As with organizational barriers the best means of minimizing pilot barriers is through education. If pilots can be assured that the sole purpose of a CRM program is to increase their effectiveness in the cockpit and that any assessment would be done by their peers in a constructive, confidential, and non-punitive manner, this barrier could be overcome. The focus of pilot education on CRM must also be to improve conventional programs that do not already include CRM; and to make it very clear that CRM training is more than just a remedy for skill areas that may have been neglected in the past, but training that will significantly improve the cockpit work environment for all crewmembers.

THE EFFECTIVENESS OF CRM TRAINING
Working Group IV-B

Capt. Jeremy Butler, Chair
Sheryl L. Chappell, Vice-Chair

INTRODUCTION

This Workshop had participants from many disciplines, including the military, airline pilots, management and union representatives, regulatory authorities, national and international agencies and institutions, academia and the business community. We were asked to present a collective view; this paper is the agreed result of our deliberations.

IS CRM TRAINING WORKING?

Industry-wide CRM training is in its infancy, and although there are a number of practitioners, we are not yet able to judge its success. There is, however, an intuitive feeling that CRM training may be effective.

In order to address the effectiveness of the training, we must look at available data. Some of the sources, from the crudest to the finest, are:

1) Number of Accidents Attributed to Human Error

(Note: due to a relative scarcity of accidents in the civilian community, accident analysis may not always provide statistically significant results as to causes and trends. However, the military indicates they individually and collectively possess an accident analysis data base of sufficient size for significant causation and trend analysis.)

2) Number of Incidents Attributed to Human Error

3) Cockpit Flight Data Recordings

4) Cockpit Voice Recordings

5) Subjective Evaluations of (or by) Crews,
e.g., quality of communications or number of errors.

Each organization has gone into CRM training for different reasons. Elimination of accidents is the prime motivator in all cases, but operators may have more refined and varied requirements; therefore objectives for that training should be addressed individually. The principles of CRM are common to all operators, but they are not

directly observable. Specific behaviors are observable, however they vary with operational contexts. For example, everyone wants a captain to "run a good cockpit" but this is accomplished differently by the military and by air carriers of different size, style and national affiliation.

Research is needed to identify the behaviors that promote or accomplish good cockpit management.

SHOULD WE UNDERTAKE A FORMAL RESEARCH EVALUATION OF CRM TRAINING?

A formal scientific evaluation is needed. The industry is encouraged to support research to:

1) Specify objectives of individual specific operators: There is general agreement that accidents and incidents, due to human errors, should be reduced. Some operators have other goals, such as: increased professionalism in the cockpit, consistently higher operating standards, greater efficiency. Because training program objectives and operating procedures are different, the research should be tailored to the operator.

2) Assess how well the objectives are met progressively through the following levels:

   a) Do participants feel helped in learning CRM concepts, i.e., do they believe that the training was useful and relevant?

   b) Do participants learn how to execute the behaviors in the real world that are taught in the training setting itself, such as the simulator or classroom?

   c) Do these behaviors transfer to the cockpit under normal operations? There are numerous methods, some of which we discussed. These methods need to be verified scientifically. The methods of collecting data must have the full agreement of the participants.

   d) Do these behaviors contribute to improved safety in line performance? If the methodologies used in levels "a" - "c" prove to be successful, we will have a good handle on the evaluation of level "d."

   Note: Levels "a" and "b" measure effectiveness of training. Levels "c" and "d" measure impact on objectives.

SHOULD WE APPLY THE SAME STANDARDS OF INTERPERSONAL COMPETENCE AS WE NOW APPLY TO TECHNICAL COMPETENCE IN THE CHECKING PROCESS?

The checking process is perceived as the regulatory assessment of pilot performance, typically done on a pass-fail basis, and it is of great consequence for the careers of individual pilots.

Our view is that at the present time it would be inappropriate and counterproductive to implement mandatory checks of pilots on resource management concepts. These concepts have not yet been fully developed, and are often "grey areas" for which reliable measurement would be difficult. Moreover, imposing required checks would inhibit both the research required for the next stage of development of resource management concepts, and would likely result in rejection of resource management training by flight crews.

We recognize the criticality of on-going feedback to flight crews to reinforce and maintain currency in effective cockpit resource management, and to build the database of crew behaviors that will be essential to further development and evaluation of resource management programs. Therefore, we recommend that NASA assist air transport organizations and aviation researchers in developing: a) training programs for personnel who would observe crew performance and give feedback to crews and crew members, b) tools and methods for collecting and summarizing those observations, and c) databases of observational results for use in on-going CRM program development and research.

It should be noted that we are avoiding use of the words "check", "evaluation" or "assessment" because of their negative associations, and because the main purposes of the observational process is to help crew members, management, and researchers in improving cockpit resource management over the long term. Also, the specific tools that would be used in a given flying organization would need to be tailored to the resource management objectives of that organization, and to the focus of their CRM program. We note that some useful tools already are available and in use by some organizations and we encourage the further development and refinement of those tools and methods. We also recognize that there are some significant differences in this regard between military organizations (where checking is done to assess both resource management performance by crews and CRM program effectiveness) and civilian organizations (where there exists considerable opposition to such checks).

Our thinking about individual resource management behavior has a parallel for crews as intact units. We are excited about the opportunity to measure how crews as units perform on resource management concepts, and encourage NASA to foster and support further research aimed at developing data collection tools, feedback processes, and archival databases regarding crew-as-a-whole performance on resource management concepts. Again, the nature of the tools (and indeed, whether or not crew-as-a-whole data are collected at all) will depend upon the particular resource management and training program objectives of the airline or military unit.

Finally, we note the interesting possibility of developing a "menu" of observational tools and procedures, at both the individual and team levels of analysis, from which particular air transport organizations could select (and perhaps modify) those devices that are particularly appropriate to their objectives and useful for their training and program development purposes.

CAN WE REQUIRE CRM STANDARDS OF PERFORMANCE UNDER CURRENT GOVERNMENT REGULATIONS GOVERNING TRAINING?

We first recognized that there are no explicit provisions within current regulations governing CRM training or evaluation. In discussing this matter, we found it more productive to address ways in which air transport operators can influence the regulatory environments in which they operate--in effect turning the original question upside down.

We feel it is the responsibility of the CRM experts within the aviation community to provide guidance to the regulatory authorities regarding the development and refinement of regulation so that they strongly support and encourage the development and implementation of effective CRM training, and research on the impact of that training. Again, we recognize that each organization has a unique situation with which to deal, and that all have a responsibility to make sure that their views about what is needed to promote CRM is heard by regulatory authorities. Those of us with special expertise in CRM should take the initiative to influence the regulatory environment in favorable directions--rather than wait for the authorities to come up with regulations on their own and then try to fit research and training programs within them.

WHAT BARRIERS EXIST TO THE OPTIMAL USAGE OF THE CRM CONCEPT?

In addressing this question, we decided not to generate a long list of potential barriers and problems--even though realities such as the economics of CRM training are ever-present and often problematic. Instead, we focused on the need to rely far more on ENCOURAGEMENT than on ENFORCEMENT in promoting program development and research on CRM.

CRM TRAINING IN CORPORATE/REGIONAL AIRLINE OPERATIONS
Working Group V

Capt. Mike Yokum, Chair
Capt. William Monan (ret.), Vice-Chair

This panel represented corporate and regional airline operational interests in Cockpit Resource Management (CRM) philosophy. The objectives of this working group were twofold: 1) consideration of the broad, overall issues of resource management as related to the corporate and regional airline segments of aviation and, 2) development of recommended guidelines for implementation of CRM principles into small-scale, small-airline types of operations.

Initial discussion of the first objective generated a basic and primary question for the panel members: "To what extent is crew resource training needed in corporate/regional airline operations?" The group's conclusion was unanimous. "Our short-haul, multi-leg, low-altitude operations expose our flight crews almost continuously to critical phases in cockpit workload and in external environmental conditions. We need CRM as much, and probably more, than the major air carriers require it."

The panel agreed that a full-scale CRM training program represented an ideal goal for corporate and regional airline operators. However, a number of chronic and serious obstacles currently prevent any industry-wide realization of such objectives.

Rapid turnover of flight crew/training personnel is one endemic problem in the establishment of resource management programs. The small transport operations tend to serve as a flow-through channel for airmen making career transitions from single-engine piston aircraft to the heavy wide-body jets. Various conference participants reported a yearly loss-rate of pilot employees that ranged from 10 to 50 percent of the workforce. The relative low experience of replacement pilot applicants exacerbates the training problem, and makes it difficult to pursue new areas.

General discussions developed a repetitive theme: "We have a hard time defining CRM." Everyone appears familiar with the philosophy and its purpose, but no one can compress the concept into a single basic statement. Elements are fragmented. Participants suggested the preparation of a text or outline of CRM terminology; in particular, a listing of bibliographical reference materials/studies relevant to the production of CRM training programs.

A considerable number of training reference data presently available were noted. Among them are periodicals, management or sales training publications (including programs not necessarily related to aviation), basic interpersonal skills training manuals, NTSB accident files, the ASRS monthly *Callback*, university aviation department studies, and commercial aviation training programs.

It was also noted that various corporate/regional airlines currently embed resource

management principles within their current training syllabi. Standard operation procedures frequently are merged with CRM policies and CRM philosophy in order to attain optimum behavioral patterns in the cockpit.

Discussion of the second objective of the working group--the development of guidelines for integration of CRM procedures into small operator flight activities--identified a set of basic barriers to establishment of industry-wide CRM training programs.

Regional airlines differ sharply from major carriers in various operational areas. The major differences appear to be:

1) More short-haul, multiple-leg trip segments with frequent takeoff/landing cycles.

2) Minimum financial support for add-on training costs.

3) Reduced availability of crewmembers for scheduling into CRM programs.

4) Lack of simulators for a number of small operators. Part 135 services overlap with Part 121 schedules. There is an industry mix of large well-financed carriers with small companies of limited financial resources.

Corporate flying displays similar differences from the major carriers. The industry encompasses first-class, "red carpet" operations and small, spartan, one- or two-pilot workforce complements. There are no ALPA or union influences in the cockpit. Rank, seniority, and status at times are unclear issues--junior crewmembers may be in command, or two captains may crew the aircraft with the role of the PIC being determined by the flip of a coin.

Often, corporate flight departments are isolated from higher-level management, particularly in organizations where the primary business activities are unrelated to aviation. Similarly, company management in these organizations may have little knowledge of pilot concerns or flightcrew training needs. There may be direct high-level management pressures on the cockpit (i.e. in corporate flight, the "boss" may be the passenger riding in the cabin). The cost of aircraft training may be difficult to understand by those who have budgetary control in large companies. In regional airline operations, there are often severe budgetary constraints.

Despite these hindrances to corporate and regional airline utilization of CRM-type training techniques, the working group affirmed a belief that "one size fits all" (i.e., the CRM concepts already in development by major air carriers are appropriate for small operator use). This viewpoint was summarized by one member's comment, "Since regionals operate frequently in low-altitude airspace and accomplish more takeoffs and landings--areas where most airline accidents take place--we probably need CRM training

more than the long-haul big carriers do."

With such variable sets of economic and operational barriers, the panel concluded that industry adoption of a full-scale CRM training program was currently unfeasible and beyond the financial capabilities of many small corporations.

Therefore, a series of stage levels in CRM training programming were developed by the working group. These steps consisted of building block options that could be progressively adopted by any transport operator according to financial constraints:

1) Development of pilot awareness of CRM policies through distribution of booklets, pamphlets, republished articles/studies, and videotapes stressing "this could happen to you" types of incidents or accidents.

2) Conduct of in-house seminars for crewmembers utilizing role-play for demonstration of CRM techniques.

3) Phase-in of CRM principles into current new-hire F/O training programs. Open cockpit atmosphere and assertiveness training would be key elements in such training.

4) Integration of CRM policies into recurrent ground school curriculi, into captain upgrade training, and into Flight Ops Manuals.

5) Recruitment of a core-nucleus of training-staff personnel for development of in-house CRM training programs.

6) Use of flight simulators using CRM-related scenarios.

7) Employment of an outside consultant for preparation of in-house CRM programs.

8) Outright purchase of a complete CRM program from a third-party vendor.

In summary, the working group determined that CRM Training is an essential element in corporate/regional airline operations. One recurring theme sounded throughout all panel discussions:

> "Go home, go back to your airlines and start doing something about it. No matter how small the training budget, take that first step toward a comprehensive, integrated CRM training program."

MILITARY APPLICATIONS OF CRM*
Working Group VI

Col. Timothy H. Hatch, Chair
David R. Nelson, Vice-Chair

INTRODUCTION

COL. HATCH: The military CRM applications groups was assigned to develop recommendations that address specific military needs. At first, we probably considered that assignment in too narrow a context and attempted to address military-unique factors. However, we soon realized that those areas had been well-covered by Capt. Dale Cavanagh from United Airlines Services Corp. and Dr. Ken Williams from the Seville Division, who was a member of our group.

After thrashing around regarding military differences, we realized we had a much larger issue to discuss. First, we had to come to grips with the enormity of the task that we had been presented with--introducing CRM to the military community. By military community, we are talking about the Army, Navy, Marines, as well as, the Air Force. We recognized that the majority of our discussion would be from an Air Force standpoint, and further, that the majority of the discussion would be from a Military Airlift Command standpoint, because that is the organization primarily represented here.

Even narrowing our focus to MAC left us with a broad spectrum to deal with when you consider the many different types of aircraft and missions represented within MAC, as Gen. Brown pointed out. Within the Air Force, there are also the Strategic, Tactical, Air Training, and several other Commands to consider. The smaller ones have had very little involvement with CRM Training to date.

So when we looked at all that, we experienced a considerable amount of empathy with Ed Cook from the FAA when he discussed the wide spectrum of operations that fall under the FAA's regulatory umbrella. We also understood the FAA's reluctance to mandate CRM programs, while at the same time desiring to encourage their development at all levels.

As an overview, we discussed what we believed were the essential elements of a military CRM program, and we agreed that we should encourage the implementation of those programs. We also did discuss military-unique aspects, but did not spend a great deal of time on them.

One of the first "essential elements" we discussed was the academic component. Here we considered many topics such as group dynamics, leadership, followership, team concepts, situational awareness, interpersonal communications, and cockpit management techniques. These are the same items that are well addressed by the curriculum

* Edited from transcripts of the oral report. An expanded version of this report is presented on p. 298.

development working groups.

We felt that role-playing situations that provided a means of feedback are a very important ingredient. MOST training is particularly important, but heavily influenced by simulator capabilities, which are more variable than in the the civilian, large aircarrier world. In the military, simulator capabilities range from a fully-integrated weapons system trainer with daylight visual systems (such as modern C-130 simulators), to simple night-vision simulators, to simulators with no visual systems. We also train for aircraft types where there are no simulators at all. However, regardless of the quality and availability of simulator facilities, we felt that role-playing in some form was necessary and could be developed as it was in the program described by the 349th MAW.

We also felt that repetition was an essential element and that CRM training should be integrated into all aspects of training. We firmly believe that a fully-integrated CRM program should be an integral part of the entire aircrew training spectrum. The integration should begin with undergraduate pilot training, undergraduate navigator training, and the initial courses for the electrician, engineer, loadmasters, and all crew positions in all weapons systems. Wherever crewmembers go to get their initial qualification training, they should receive CRM as part of their training at that point in their careers. But perhaps most important, they should get continuation training throughout their careers conducted at the unit level.

We felt that these were the essential elements that had to be addressed, and we spent most of our time on the next issue--implementation. We thought high-level Command emphasis was the most essential aspect of implementation. Many organizations have discussed implementation, however from our perspective, civilian operators have a relatively simple problem compared to the military's large number of commands, aircraft types, branches, etc.

Getting the required amount of Command-level support down to all operational entities is a formidable task. We felt that it had to be initiated at the Air Force Headquarters level and work its way all the way down to the unit squadron operations officer. However, we also felt that program development had to be done at the operational level. Perhaps the most logical would be the wing level. Even at the wing level, we are talking about larger organizations than many civilian airlines. For example, a typical C-141 Wing (there are six) is composed of about 60 aircraft and perhaps 90 aircrews. This is probably the lowest practical level that can accommodate a specific aircraft type and particular mission. We felt that it was important for CRM programs to take into account these operational differences, hence some level of development at the wing level.

Education is an important part of implementation, and this implies specific education for both management and the aircrews. We hope that the proceedings document from this workshop will provide us with a "launching pad" to begin educating the large number of diverse organizations that we are going to have to deal with. Our working group strongly feels that CRM is an essential safety training requirement for all flying units and that it should include all aircrew members and be integrated into the entire training system.

We also felt that once you begin to get command emphasis, the second portion of the education effort should be the education of the aircrews themselves. This phase can start out in Command magazine articles, safety conferences, and also Command conferences on CRM. However, the number one issue is obtaining an adequate amount of Command emphasis and support.

Dutiful to our assignment, we did eventually get around to talking about the military-unique factors--rank, mission, crew qualifications, turnover, experience levels, etc.--all of those things that are different from the typical civilian application. However, that process is kind of like saying, "You look funny because you're in a blue suit." Those of us who wear blue suits all the time don't think we look funny. So we're used to dealing with these particular factors as a way of life. In other words, they should not become major preoccupations.

We did come to one conclusion that we felt was very important. Despite the emphasis that has been place on the civil-military differences in a recent study, we completely agree with the conclusion of that study that military CRM Training will contribute to the safe, orderly, and expeditious accomplishment of our mission. As such, it should become an integral part of our training program.

DISCUSSION (Working Group VI)

COL. LEE: I just wanted to know if your group--since I didn't have an opportunity to sit in on it--discussed the duplication of effort that is already ongoing in our training programs. What I mean by that is--that our programs on a day-to-day or month-to-month basis include aircrew safety meetings, aircrew seminars, certification boards, and current flight evaluation processes such as line operational checks, and O.R.I.'s just as a beginner. And all of them looked at crew coordination, judgement, and the other kinds of things that we've been talking about here for the last three days. Did you go into that and how CRM either duplicates or interjects itself into those other programs?

COL. HATCH: We did not really address that. I suppose my answer would be similar to the ones that other people have previously given to the other gentleman's (Capt. Eames') question. I think we failed somewhere else along the line, perhaps in our initial selection process, in our instructors, or wherever; and maybe it's part of airmanship along those same lines.

Yes, it is an additive sort of thing and perhaps it does duplicate some of those things you're talking about. But it also meets a need that I think has been addressed rather clearly here. I think CRM formalizes and adds a great deal to it.

If you do talk about other duplications of efforts, as we develop all of these things, if you have a corporation that heads, say 300 airplanes, and you're developing that program for yourself you end up with a lot of programs. Then when you put them all together, you'll see there is a great deal of duplication between how this one goes about it and the other one goes about it. At this point, I believe the intention is to go ahead and let that duplication take place. And then after it's become more solidified, and we've

actually got a hold of this program the way we want to, then we can better formalize it. At this point, the formalizing part is what we're trying to down play.

GENERAL DISCUSSION AND CONCLUDING REMARKS

DR. FOUSHEE: I think that you can all give yourselves a round of applause for the work you have done in the groups. I am terribly impressed with the quality of those reports, and I would like to thank all of the working group chairs, vice-chairs, and certainly all of the participants in this process for all of the hard work you so obviously put in. I did manage to visit all of the groups, although I was not able to spend very much time in any one. However, I was amazed at the spirited nature of the discussions, and at the extent to which people really put their hearts into this whole process. I think that the recommendations stemming from your deliberations will be very useful. For that, I thank you all very much.

At this time, I would like to invite Ed Cook (FAA), Richard Hackman (Harvard), Bob Helmreich (University of Texas), and John Lauber (NTSB) up to the podium for their final reflections on the workshop and the state of CRM training.

DR. LAUBER: I hope that all of you are feeling as satisfied as Clay Foushee, Ed Aufderheide, and I are. I also have a great deal of sympathy and empathy for what Clay and Ed have been through in putting together this meeting. When I saw them yesterday afternoon, after the first couple of hours of your working group deliberations, there were heads being shaken, long-looking faces, and genuine puzzlement as to how anything meaningful and constructive could come out of such a process. However, I never cease to be amazed at how well this process seems to work. I, like Clay, spent time yesterday going from group to group, and it was clear that every time you walked into one, a very intense, dedicated group was clearly thinking very seriously about problems and issues that need to be addressed. So even before I had heard any of the reports, it was safe to say that this workshop was very successful. It is an incredible thing to see, and some day, I'd like to do a study on the working-group process itself. But, I think you can see from the quality of the reports, from the comments, and from the ideas and suggestions made, that this workshop was, in fact, a very successful venture.

There are several comments that I noted during the course of listening to each of the working group sessions, and they are in no particular order. In fact, many of the points that I had intended to make have already been made in the working group reports. I was thinking as I made these notes that I had a brilliant idea, and that notion was reinforced by the fact that many others made similar points very eloquently. So I can make my remarks very short.

I would like to point out that the panel up here consists of a majority, a heavy majority, of psychologists. It's kind of unusual, I think, in the experience of many of you people, to find psychologists and pilots carrying on constructive and meaningful dialogue. This effective interaction between the academic community and the operational community is a prime example of the synergy that is at work in this area.

One point I'd like to address regards Capt. John Eames' remarks about airmanship.

I agree with him completely in the sense that it is exactly what we're talking about when we refer to CRM. However, what we have done with the concept in workshops like this is to put some meat on the bones, to put some substance and structure to the idea of airmanship. We have been able to identify dimensions of it, and to further refine specific approaches that can be taken to solving the problems of human-error accidents, and that is the reason we are all here in the first place. Elimination of those types of accidents will be the ultimate means of assessing the effectiveness of this type of training.

Another recurring theme that I do not recall hearing before concerned the integration of CRM into all aspects of training. Integration, at all levels from the most junior crewmember to the most senior. Integration, in the sense that CRM must be addressed throughout all aspects of a pilot's career. We need to start when that person enters the system and follow them all the way through. But, I also noted recommendations regarding integration in another sense--not just cockpit crewmembers and cockpit resources, but with all other resources in the system. We're not just talking about the cockpit, it doesn't stop at the cockpit door. It includes the cabin crew, it includes loadmasters, and others.

Another theme concerned problems with evaluation and regulation, and I think they are interrelated. The fundamental problem is not to confuse evaluation and critique. Everyone seems to agree that critique is vitally important. I am talking about evaluation in a more global sense. Part of the problem is definitional and relates to the problem of regulation. Regulations are written to govern behavior--the behavior of individuals. The laws and the approach to regulation is upon individual performance, it is not on team performance in the sense that we discuss crew errors. That's where the fundamental problem is going to be, and I don't see any real way around that problem. We also have to be concerned, in the long-run, about the evaluation of the effectiveness of these programs, and while elimination of accidents is the ultimate goal, we need other ways to check our progress.

A couple of ideas occurred to me in the course of thinking about other resources. One was triggered by a specific suggestion from Roy Butler's working group report. It is possible that the ASRS (NASA/FAA Aviation Safety Reporting System) could be used to provide, on a periodic basis, a summary of significant CRM-related incidents that could be used as source material for those putting together training programs. It would be a potentially good source of educational material. It is also a specific suggestion to Bill Reynard (Chief of ASRS) that there is a role for ASRS to play in this area.

Another that occurred to me was a consideration of the use of home computers, in some way, for simulation. A lot of pilots now have home computers, and there are a lot of clever ways to use them. It might be possible for training organizations to distribute disks, for example.

Another comment is related to Roy Butler's group problem with appropriate terminology for CRM training, to the extent that they resorted to use of the term, "IT," because they couldn't resolve it. Well, I would like to suggest that they did resolve the problem, they just didn't realize it. "IT" should stand for integrated training (laughter).

I am going to close with one additional comment, and it is one that I can make now

that I am not associated with NASA. I want to point out something that Clay probably wouldn't, out of modesty, if for no other reason. It concerns the unique and valuable role that NASA plays in this kind of operation. It is difficult to conceive of another organization playing that kind of role, due in part to the neutrality of NASA and in part to the competence and quality of its staff and facilities. I think that it is important for all of you to recognize that NASA is facing, like all government agencies, severe budget pressures and related problems that affect allocation of resources. They have a real resource management problem in their own right. A number of the decisions that are made with regard to how those resources are allocated are dependent upon the views of key NASA management, Congress, and the Administration. So I guess what I am saying is that it is important for those of you who feel that NASA's role is vital to make sure that the word gets to people who can make a difference. As you can see, I am unabashedly putting in a plug for you to do whatever you can as individuals and through your organizations. Obviously, I view this work with a great deal of enthusiasm and strong support. It is more important than ever before, and I am very concerned that NASA may not be able to support the work that needs to be done.

With that, I'd like to turn the podium back over to Clay, and once again congratulate Clay and Ed for doing an outstanding job in organizing this workshop. I hope at some future time, I can participate in another.

DR. FOUSHEE: Thank you John for the kind words and insightful observations. Are there other reflections?

MAJ. AUFDERHEIDE: Those of you that have known me for any length of time know I never miss the opportunity to speak, and I wanted to take this opportunity from the "blue suit" (Air Force) side of the house to thank Clay. Without his support, I don't think this workshop would have been near the success it has been. We had a great deal of success with a smaller workshop within MAC last year, and I asked Clay if he would be interested in supporting a larger initiative. I felt MAC had something to offer, but as John Lauber put it so aptly, NASA provides credibility and neutral turf which are very important. This neutrality is very important because we all have our parochial differences, but we also have a common objective--increased aviation safety.

I too watched the working group process very closely, and was very impressed with the broad spectrum of views and recommendations. We have areas of consensus, but we also managed to account for a lot of diversity.

I have lost friends to aviation accidents, and that is what I am here for--to try to keep it from happening again. From what I have seen the last three days--the energy, enthusiasm, and resources being channeled to try to find the answers--I am confident that we have an opportunity to make a significant impact with regard to aviation safety.

So I want to salute you all, and say that I have never seen so many people make so few look good. Clay and I just set the stage, and you came out and performed in fine style. One behalf of the Air Force and our sister services, I thank you all for coming. It has been a very enjoyable experience.

PROF. HELMREICH: I think we all came with different expectations. I know I did,

but they were all met and even exceeded. Perhaps some of us came thinking we would find CRM training on the shelf and take it home. We didn't, and I think that is probably good. Perhaps some of us came thinking we were going to make a mid-course correction, and then be totally on-target, and we found out that it was going to be a little more complicated than that. I think what we have come out with instead is a template that lays out a lot of work and shows gaps, but also tells us how far we have come. That, I think, is a very splendid outcome.

I would also like to turn to an upbeat note because we consistently talk about building CRM training based on negative instances. It came up during the working group presentations. Of course, that is why we are in this business--because of the negative instances. One of the things I think research absolutely has to do is to find out the state of resource management in the system so that we can determine how we are impacting it. But, in the process of doing that research, we are going to come across some wonderful data--instances of brilliant resource management. Unfortunately, we tend to document these infrequently. If we can document this optimum behavior, we can create compelling role-models and maximize the effectiveness of our training. To me, this is an exciting challenge.

DR. FOUSHEE: There is really very little else I can say. In the course of this workshop, we have heard about "shells," we've heard about "holding hands in hot-tubs," and we have also heard some very fundamentally important concepts regarding the effects of personality and attitudes on behavior--what things can and cannot be reasonably expected to change--what types of training can successfully address various parts of a complicated equation. But, I am sure that we are all at or near the saturation point.

So all I want to say, very simply, is that it has been a real pleasure to work with all of you, and we at NASA are very gratified to have this type of association with the aviation community. We'll work very hard on our end to continue it in the future.

With that, I would like to formally close the NASA/MAC Workshop on "IT," whatever "IT" is.

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Jenkins (616 MAG)
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Harford (SAC)
Williams (Seville)
O'Such (HQ USAF)

AGENDA:
NASA/MAC WORKSHOP ON
COCKPIT RESOURCE MANAGEMENT TRAINING

May 6-8, 1986

May 6, 1986

0730-0830 - Registration and Coffee

0830-0900 - Workshop Overview and Administration
Dr. H. Clayton Foushee, NASA, Workshop Co-Chair
Maj. Edward H. Aufderheide, MAC, Workshop Co-Chair
Dr. David C. Nagel, NASA, Chief, Aerospace Human Factors Division

0900-0945 - Cockpit Resource Management: Background and Overview
Hon. John K. Lauber, Member, National Transportation Safety Board

0945-1045 - Theory Underlying CRM Training
Dr. Robert L. Helmreich, University of Texas
Dr. J. Richard Hackman, Harvard University

1045-1100 - Coffee Break

1100-1200 - United Airlines Resource Management Training
Capt. J. Edward Carroll, UAL (ret.), CRM, Inc.
Dr. William R. Taggart, CRM, Inc.
Capt. David Shroyer, UAL (ret.), Consultant, CRM Training

1200-1300 - Lunch

1300-1330 - People Express Airlines CRM Training
Capts. Keith Bruce and Doug Jensen
Capt. Robert W. Mudge (ret.), Cockpit Management Resources, Inc.

1330-1400 - Pan American CRM Training
Capt. Roy Butler, Director B-747 Training

1400-1430 - Continental Airlines CRM Training
Capt. Darryl Christian, Assistant Chief Pilot

1430-1500 - Japan Air Lines CRM Training
Capt. Hisaaki Yamamori, Director, CRM Development

1500-1515 - Coffee Break

1515-1545 - Trans Australia Airlines CRM Training
Capt. Jim Davidson, Flight Supt., Training
Dr. Charles Margerison, University of Queensland

1545-1615 - Remedial Training: Will CRM Work for Everybody?
Capt. A. N. Johnston, Chairman, Human Performance Committee, IFALPA

1615-1630 - IATA Survey of CRM Training Needs
Mr. Lawson C. White, Director of Flight Operations, IATA

1630-1700 - General Discussion

1800 - Cash Bar

May 7, 1986

0800-0815 - Introduction to MAC CRM Training
Maj. Gen. Donald D. Brown, Commander-in-Chief, 22nd AF

0815-0900 - The Application of CRM to Military Operations
Capt. Dale E. Cavanagh, UAL Aircrew Training, Inc.
Dr. Kenneth R. Williams, Seville Training Systems

0900-0915 - CRM Training in the 1550th Combat Crew Training Wing
Capt. Mike Fiedler, Kirtland AFB

0915-0945 - CRM Training in the 349th Military Airlift Wing
Lt. Col. Conrad S. Biegalski, Travis AFB
Maj. John T. Halliday, Travis AFB
Maj. Anthony Inzana, Travis AFB

0945-1015 - CRM Training for FAR Parts 91 and 135 Operators
Mr. Neil C. Krey, Manager, Instructor Training, Simuflite
Mr. Don Rodgers, Director, Training Standards, Simuflite

1015-1030 - Coffee Break

1030-1100 - CRM Training for FAR Parts 91 and 135 Operators
Mr. Douglas Schwartz, Asst. Dir., Flt Stnd., FlightSafety Int'l.

1100-1130 - The Regulatory Horizon
Mr. Ed Cook, Training and Tech. Standards Division, FAA

1130-1200 - Instructions to Working Groups

1300-1700 - Working Group Meetings

1700 - Working Group Chairman Meetings

1800 - Cash Bar

May 8, 1986

0800-1100 - Working Group Meetings

1100 - Working Group Chairman Meetings

1330-1400 - Topic # 1 Report - CRM Curriculum Development

1400-1430 - Topic # 2 Report - Techniques for CRM Training

1430-1500 - Topic # 3 Report - Integration into the Total Training Effort

1500-1530 - Topic # 4 Report - The Effectiveness of CRM Training

1530-1600 - Topic # 5 Report - CRM for Corporate and Regional Operations

1600-1700 - General Discussion and Workshop Wrap-Up

ADDITIONAL PAPERS

EDITORS' NOTE: Due to the level of interest in the workshop, the organizers were not able to accommodate all of the presentations pertinent to the subject of Cockpit Resource Management Training. In addition, some relevant papers were supplied to the editors after the final agenda had been decided. In the following section, several of these papers are presented with the hope that they will be of use to those interested in CRM Training.

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DYADS AND TRIADS AT 35,000 FEET: FACTORS AFFECTING GROUP PROCESS AND AIRCREW PERFORMANCE[1]

Dr. H. Clayton Foushee
NASA-Ames Research Center

INTRODUCTION

The large percentage of aircraft incidents and accidents attributed to "human error" has focused increasing attention upon the performance characteristics of the individual pilot. Traditionally, human factors specialists have channeled their research energies toward exploration of the human information processing and perceptual aspects of the pilot's job with the important goal of designing equipment best suited to the characteristics of the human operator. Human factors psychologists and aeronautical engineers have continually refined designs on the basis of an improved understanding of human operators to the extent that each new generation of aircraft not only promises better performance, but also reduced pilot workload. Despite this effort, about 65 percent of all accidents continue to fall into the human error category.

As a direct result of the limitations and imperfections of individual humans, multi-piloted aircraft cockpits were designed to ensure needed redundancy. Yet, this redundancy has failed to provide an adequate margin of safety in some cases. It has failed too often because captains have not heeded the warnings of other crewmembers. It has failed because crewmembers who possessed adequate information have for some reason not provided it to others. In fact, a review and analysis of jet transport accidents worldwide during the period from 1968 to 1976 (Cooper, White, & Lauber, 1979) revealed more than 60 in which breakdowns of the crew performance process played a significant role. Although individual pilot performance remains an important research topic, these occurrences suggest that more attention need be placed upon crew performance and the factors which affect crew coordination.

Webster's New Collegiate Dictionary (1961) defines *cockpit* as, "a region noted for many conflicts." Although this definition does not specifically apply to aircraft cockpits, we have found it interesting to note how often interpersonal phenomena can affect air transport operations. Since the cockpit crew is a highly structured small group, a number of socio-psychological, personality, and group process variables are relevant to crew effectiveness. The complexities of the operational environment, aircraft systems, and the sheer volume of information that must be processed (often in brief periods of time), mandate highly coordinated team performance. Rigorous company hiring practices, employment conditions, and regulations requiring frequent checking and retraining have together assured that each crewmember is a highly skilled professional. However, in situations where a high level of teamwork is required, the individual skills of

[1] EDITORS' NOTE: This paper orginally appeared in *American Psychologist, 39*, August, 1984. Because it discusses many of the theoretical and practical issues related to CRM training, it is reprinted here.

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team members are often not enough to guarantee satisfactory outcomes in all situations. Jones (1974) illustrated this assertion in a study of professional athletic teams. Teams with better athletes seem to win more often, but the strength of this relationship is dependent on the extent to which the particular sport requires teamwork. Jones found that 90% of baseball team effectiveness was predictable from the skills of individual team members, while only 35% was predicted by this factor in basketball teams. In explaining this result, the author notes that basketball is critically dependent upon personal relations and teamwork.

Despite the fact that thousands of studies of group performance have implicated many variables (Hare, 1972; McGrath & Altman, 1966), group performance problems have received relatively little attention in the aviation research and training communities. However, awareness of these problems is gradually increasing. Following an airline accident in 1978, in which the crew was preoccupied by a minor mechanical malfunction and allowed the aircraft to run out of fuel, the U. S. National Transportation Safety Board, a government organization whose major responsibility is the investigation of transportation mishaps, stated in their report of the accident (NTSB, 1979b):

> The Safety Board believes that this accident exemplifies a recurring problem--a breakdown in cockpit management and teamwork during a situation involving malfunctions of aircraft systems in flight. To combat this problem, responsibilities must be divided among members of the flightcrew while a malfunction is being resolved. . . .
>
> Admittedly, the stature of a captain and his management style may exert subtle pressure on his crew to conform to his way of thinking. It may hinder interaction and adequate monitoring and force another crewmember to yield his right to express an opinion. (pp. 26-27)

In 1982, subsequent to an accident in which the aircraft struck a bridge shortly after takeoff and crashed into the Potomac River, the Board (NTSB, 1982) ruled that the captain of that aircraft did not react to the copilot's repeated, subtle advisories that all was not normal during the takeoff. Moreover, the Board implied that the copilot's lack of assertiveness (possibly induced by the inherent role structure of the cockpit) may have been a causal factor in recommending that pilot training include "considerations for command decision, resource management, role performance, and assertiveness." (pp. 67-68)

It is unfortunate, in light of the increasing awareness of group performance variables in air transport operations and the volume of research dealing with group function, that we still know little about why some groups perform better than others. There are at least two principal reasons for this apparent shortcoming. First, it is difficult to assimilate the sheer number of variables that can potentially affect group processes. This poses methodological difficulties that have forced those concerned with group performance to attempt to isolate a few variables at a time in any given experiment. Thus, the literature is characterized by a collection of seemingly inconsistent results, each study examining the effects of a different subset of relevant factors. The second point concerns the fact that most of the closely controlled studies have taken place in

laboratory settings. Given the obvious difficulty of maintaining experimental control in the real world, we have relied upon more comfortable environs. As Helmreich (1975) has noted, we may have sterilized our research through an over-reliance on the laboratory, the result being that organizational decision-makers in the aviation community and elsewhere have been less likely to concentrate on solutions to group performance problems. They have instead focused on the more manageable problem of what to do about individual performers.

It would appear that a partial explanation of the inconsistency and lack of robustness of the literature is inherent in the research methodology itself. The practice of looking at isolated variables has contributed to a state of affairs where factors that make big differences in group behavior are held constant because they are neither easily controlled nor manipulated in the laboratory and where potentially important intervening variables are often ignored. As Hackman and Morris (1975) have noted, most studies examine only parts of a complicated phenomenon such as the contribution of input factors (e.g. member skills, attitudes, and personality) to the outcome factor (e.g. group productivity), ignoring that it may be the *process* of group interaction that holds the key to understanding group performance. For example, a study examining the effect of group member personalities (an input) on performance (the output) might discover meager or non-existent statistical associations, and as a result one may infer that such profiles are unrelated to group performance. Yet, this inference may be entirely incorrect. It is possible that the same personality profiles would be strongly related to intervening process variables such as communication patterns or other interactional behavior. These process variables, in turn, might be related to the outcome variable. Thus, mediating variables might account for most of the relationship, but have often been overlooked.

The group interactional process has been alternatively viewed as both a positive and negative feature of tasks performed by groups instead of by individuals. Hackman and Morris (1975) have noted that, "It is tempting to conclude that the 'group effectiveness problem' will not be solved in the foreseeable future, and to recommend to decision-makers that in the meantime they use groups as infrequently as possible." Steiner (1972) characterizes group performance in terms of "process-loss", which inhibits the group from reaching its potential. Others (e.g. Hackman & Morris, 1975) propose that interaction among group members performs the valuable function of preventing errors that may occur if individuals perform the task in isolation; and that despite the inefficiency of the process, it is acceptable in any situation where error-free performance is necessary. This notion, that substituting groups for individuals results in error-free performance through redundancy, has been challenged. Janis (1972) proposes that this process is frequently compromised by "groupthink" in close-knit groups, a phenomenon characterized by a marked decrease in the exchange of discrepant or unsettling information, even when it is forced to the attention of members.

In the sections that follow, I will review some of the input, process, and outcome variables in the small group performance situation faced by aircraft flightcrews. A strong emphasis is placed upon the group process. Hackman and Morris (1975) have argued eloquently for this approach, and their work has been a stimulus for this application. More specifically, the focus here will be upon links between personality or interpersonal styles of leadership as input variables; communication patterns and crew

coordination as group process variables; and upon operational errors, incidents, and accidents as outcome variables. A concluding section reviews some of the ways that the air carrier industry is now addressing group performance problems.

In some sense, this application of small group theory to the flight deck is facilitated by the fact that we are dealing with groups operating within a tightly prescribed operating environment (relative to many group tasks) and with a clearly defined role structure (captain, first officer, and second officer or flight engineer). Thus, certain input factors such as task characteristics, reward structure, position power, stress levels, etc. are relatively constant within this particular type of group.

INPUT VARIABLES AND THE FLIGHTCREW PROCESS

There are numerous input conditions that affect the group interactional process, but member personality characteristics and individual differences have probably received the most attention. Moreover, organizations concerned with pilot selection have utilized personality inventories for years, but as Helmreich has noted (In Cooper, White, & Lauber, 1979), such efforts have usually been oriented toward the screening of pathology.

In the group research domain, leadership studies have concentrated heavily upon the identification of "profiles" or personality characteristics which are associated with successful leadership. Fiedler (1967) and coworkers undertook an ambitious program to identify those profiles most pertinent to successful leadership. It is impossible to detail the findings of this program here, but briefly stated, Fiedler identified two basic types of leadership profiles, task-oriented and relationship-oriented, which were related to group performance in a complicated interactive fashion. Not surprisingly, the type of leadership style that was most effective was heavily dependent on the type of group and the task with which the group was charged. In groups with highly structured tasks and powerful leader positions, such as the cockpit crew, task-oriented leaders performed better as long as interpersonal relationships within the group remained relatively good. Relationship-oriented leaders performed better in groups where leader-member relations where relatively poor. These data are interesting, but appear intuitively paradoxical. It would seem logical to posit that relationship-oriented leaders, over time, would more often find themselves in situations characterized by good interpersonal relations; whereas task-oriented leaders would more often find themselves in situations where leader-member relations are poor. While the Fiedler data may be valid for the situations tested, it could be argued that relationship-oriented leaders less frequently find themselves in situations where leader-member relations are poor. However, there are apparently no data on the relative frequencies of these patterns.

Another characteristic of this approach is that task-orientation and relationship-orientation profiles are usually treated as mutually exclusive patterns. Yet, a substantial amount of research dealing with these two global dimensions would seem to indicate that this is not the case (e.g. Blake & Mouton, 1978; Spence & Helmreich, 1978). Spence and Helmreich (1978) have conducted research that argues persuasively for the idea that instrumentality, or goal orientation, and expressivity, or interpersonal orientation, are

orthogonal. Blake and Mouton (1978) suggest that the most effective style of leadership or management is associated with a profile that encompasses both sets of characteristics. Thus, there is increasing interest in the notion that both task orientation and interpersonal orientation are necessary for the effective management of all situations. The concept that these two sets of attributes can be present in one individual and balanced depending on the situation is perhaps a more appealing concept for decision-makers than theories that suggest an inverse relationship between the two. Previous approaches (e.g. Fiedler, 1967) have speculated that the decision-maker should assign managers to situations more in keeping with their particular leadership style. Unfortunately, this is not practical in many environments, but perhaps even more problematic is the fact that most management situations are dynamic and in constant evolution.

With respect to the flight deck, as in most performance situations, it has usually been assumed that goal orientation is strongly related to performance and that group orientation is essentially unrelated. However, Helmreich (1982) has presented data which would seem to indicate otherwise. In a study of air carrier pilots, both goal and group orientations were significant predictors of the group process variable of crew coordination.

As previously suggested, the incident and accident record has also implicated the lack of an effective interpersonal orientation as a cause of breakdowns in the group process variable of information exchange. Subordinate crewmembers complain that captains are at times so insensitive and intimidating that they hesitate to speak up even in potentially dangerous situations. We have identified the extent of this problem, in part, through a confidential data base, the Aviation Safety Reporting System (ASRS), which is a joint endeavor of NASA and the Federal Aviation Administration. This data base (which currently contains around 50,000 reports from pilots, air traffic controllers, and other members of the aviation community) has proven to be an invaluable tool for the identification of significant problem areas.

I recently reported an example of this type of behavior contained in a copilot report to ASRS (Foushee, 1982, p. 1063). Air traffic control had issued a speed restriction which was repeatedly ignored by the captain. After several attempts to convey the information, the captain responded by saying, "I'll do what I want." Air traffic control inquired as to why the aircraft had not been slowed, advised the crew that they had almost collided with another aircraft, and issued a new clearance which was also disregarded by the captain despite repeated clarification by the copilot. Following the last advisory from the copilot, the captain responded by telling the copilot to, "just look out the damn window."

The inherent danger of such situations is that subordinate crewmembers can become "conditioned" not to speak up after running into captains such as the one in the preceding report. Consistent behavior of this sort by captains (while not usually as blatant as in this example) may have contributed to the development of a normative pattern of what constitutes "appropriate copilot behavior," and there is a strong likelihood that this behavioral norm will transfer to situations where there is no reason for member effort to be suppressed.

Another report from a copilot to ASRS (Foushee, 1982) illustrates this phenomenon. This report described a situation where air traffic control had instructed the flight to level off at 21,000 feet. As they reached their assigned altitude, the copilot noticed that the captain was climbing through it. The copilot mentioned it to the captain, "but not forcefully enough and he did not hear me." The copilot mentioned it again and pointed to the altimeter at which point the captain stopped the climb and descended back to the assigned altitude. Assigned alitudes are extremely critical in dense air traffic environments, and strict adherence to these altitudes is necessary because of the likelihood that other aircraft are assigned to adjacent airspace. Because of this, the copilot was extremely concerned about the incident and summed up the reasons for this occurrence in the following insightful manner:

> The captain said he had misread his altimeter and thought he was 1000 ft. lower than he was. I believe the main factor involved here was my reluctance to correct the captain. This captain is very "approachable" and I had no real reason to hold back. It is just a bad habit that I think a lot of copilots have of double-checking everything before we say anything to the captain. (p. 1063)

It should come as no great surprise that this situation can produce, and has produced, disastrous consequences. In a 1979 crash of a north-eastern commuter carrier (NTSB, 1980), the first officer failed to take control of the aircraft when the captain apparently became incapacitated. The captain was a company vice-president and the first officer was a recently hired pilot still on probation. The captain, according to reports, was a gruff personality and was observed to be visibly upset on the day of the accident. Further, this captain apparently had a history of not acknowledging cockpit communications. Clearly, the group dynamics of that particular situation were not conducive to the first officer's assumption of control. It would appear that had the first officer not been intimidated, the accident might not have occurred. In another accident (NTSB, 1979a), a twin-jet slid off the end of the runway after crossing the outer marker approximately 60 knots over desired speed. Although the captain was apparently unaware of the excessive speed, evidence indicates that the first officer knew, but could only muster a sheepish comment about the possible presence of a tail-wind.

It is reasonable to assume that the development of a strong group norm of shared responsibility will increase the probability that subordinate crewmembers will function more effectively in critical instances. Obviously, the captain's leadership style is an important component for the establishment of such a norm, but it is by no means the only component. Apparently, the reluctance to question captains or assume control is not an isolated problem. In an investigation conducted by Harper, Kidera, and Cullen (1971) at a major air carrier, captains feigned subtle incapacitation at a predetermined point during final approach in simulator trials characterized by poor weather and visibility. In that study, approximately twenty-five percent of these simulated flights "hit the ground" because, for some reason, the first officers did not take control.

While there are no carefully controlled studies of the effects of leader and member personality profiles, such as instrumentality and expressiveness, on the flightcrew interactional process (although Helmreich, Note 1, provides some evidence), incident and accident data suggest that such profiles are important predictors of certain group process variables in the aviation environment. Research now in progress in our laboratory will

hopefully shed more light on these relationships.

FLIGHTCREW PROCESS VARIABLES AND PERFORMANCE

Researchers in the aviation environment are perhaps more fortunate than many of our laboratory research colleagues. The rapid advancement of simulator technology has provided an ideal laboratory for the study of group process variables. It is now feasible to realistically simulate virtually every aspect of the aircraft operational environment (complete with realistic auditory, visual, and motion cues) to the point where actual trips can be "flown" in a simulator, and these "flights" are almost indistinguishable from those in the airplane. Due to the high degree of simulator fidelity, it is possible to conduct controlled studies of group process variables with almost complete confidence that the results generated in the simulator are strongly (if not completely) representative of the real world (Lauber & Foushee, 1981). Moreover, the simulator allows the study of situations that are too dangerous to perform in an actual aircraft.

The best example of this use of simulation was conducted by H. P. Ruffell Smith (1979) in a study which was not originally designed as an investigation of group process, but which provided strong evidence for the importance of the group performance dimension. In that study, B-747 crews were asked to fly a highly realistic *simulated* flight from New York to London. Because of an oil-pressure problem, the crew was forced to shut down an engine. Since the trip to London could not be completed with a failed engine, the crew had to decide where to land the airplane, and the decision was further compounded by a hydraulic system failure, poor weather, less than ideal air traffic control, and a cabin crewmember who consistently requested assistance from the cockpit crew at inopportune moments. The Ruffell Smith (1979) study allowed the examination of flightcrew performance in a completely controlled setting, and there were marked variations in the performance of the crews. Perhaps the most salient aspect of this flight simulation study was the finding that the majority of problems was related to breakdowns in crew coordination, not to a lack of technical knowledge and skill. "High error" crews experienced difficulties in the areas of communication, crew interaction, and integration. For example, some of the more serious errors occurred when the performance of an individual crewmember was interrupted by demands from other crewmembers. Other performance deficiencies were associated with poor leadership and the failure of the flightcrew to exchange information in a timely fashion.

One of the most significant group process variables is reflected by the information flow within the group. The measurement of relational communication has been utilized over the years by a number of researchers in various paradigms (e.g. Bales, 1950; Mark, 1970). In studies that have examined the relationship between group process variables and performance effectiveness, careful analyses of the communications process have often proven fruitful. Lanzetta and Roby (1960) monitored and recorded all communications during a group performance task. Their study found that this particular measure of group interaction predicted task success better than such measures as member knowledge and skill. These authors suggest, in a quote that might as easily have come from one of the NTSB accident reports, that "the way the group 'utilizes' its resources and the procedures it employs for communicating essential information are as important,

if not more important than 'knowledge' of the problem for determining its performance."

In a separate investigation designed to look at the group process, we (Foushee & Manos, 1981) analyzed the cockpit voice recordings from the Ruffell Smith (1979) simulation study utilizing a technique adapted from Bales' (1950) interaction process analysis. Several interesting relationships emerged from the Foushee and Manos (1981) study. Overall, there was a tendency for crews who communicated less not to perform as well, but the type or quality of communication played an even more important role. There was a negative relationship between crewmember observations about flight status and errors related to the operation of aircraft systems. In short, when more information was transferred about aspects of flight status, fewer errors appeared which were related to such problems as mishandling of engines, hydraulic, and fuel systems, the misreading and missetting of instruments, the failure to use ice protection, and so forth.

It would appear that information exchange of this sort facilitates the development or coordination of strategies through the assurance that all members have access to the relevant information. However, there may be a negative side to the complete coordination or sharing of strategic plans unless group norms specifically allow for the processing of discrepant information. As Janis (1972) has pointed out, group processes often lead to situations where information discrepant with the group's strategic course of action is ignored or deemphasized, even when it is critically relevant. This can theoretically occur not only in groups where interpersonal relations are strained, but also in groups where there is too much agreement.

In other areas of information exchange, Foushee and Manos (1981) found a negative relationship between aircraft systems errors and acknowledgements to information provided by other crewmembers. In crews in which commands, inquiries, and observations were frequently acknowledged, these types of errors were less apparent. Acknowlegements were also related to fewer errors overall. It appeared that acknowledgements served the important function of validating that a certain piece of information had, in fact, been transferred. These types of communication also seemed to serve as reinforcements to the input of other crewmembers. This relationship suggests that communication patterns can serve to increase member effort and motivate further participation in the group process.

Commands were associated with a lower incidence of flying errors such as problems with power settings, neglect of speed limits, altitude deviations, and the lack of formal transfer of control between captain and first officer. Often communications of this type seem to assure the proper delegation of cockpit duties and facilitate coordination and planning. Yet, it should be noted that the overuse of imperative statements may have negative consequences. The use of commands provides a very good illustration of the effect of varying interpersonal styles. An identical piece of information can be related to other crewmembers in one of several different ways. For instance, a communication such as, "Ask air traffic control for a higher altitude," which would constitute a command; could also be relayed, "I think we should ask air traffic control for a higher altitude," an observation; or "Why don't we ask air traffic control for a higher altitude," an inquiry.

Foushee and Manos (1981) also found evidence for higher rates of response uncertainty, frustration or anger, embarrassment, and lower rates of agreement in crews

who tended to make more errors. Despite the fact that these correlational data do not allow inferences of causation, it is safe to infer that discord related to the comission of errors, whether cause or effect, may be related to crew coordination deficiencies downstream.

In addition to the importance of communication style, the precision of communication plays a pivotal role. The ASRS data bank contains a number of incidents in which each pilot thought he or she knew what the other meant or intended to do when, in reality, they did not. One report to ASRS described a situation where a critical alarm went off in the cockpit followed by immediate diagnostic actions by the crew. Shortly thereafter the alarm silenced, leading the captain to believe that it was probably a false warning. After landing, the captain discovered that the circuit breaker for the alarm system had been pulled by the flight engineer, that it was not a false warning, and that the warning could have been potentially serious. The flight engineer stated that he had asked the captain if he wanted the warning inhibited, and since there was no reply, he assumed he was complying with the captain's wishes (Foushee, 1982, p. 1064).

In summary, there is strong evidence that the process of interaction is related to group performance in the cockpit environment. The reader should bear in mind that the results of the Ruffell Smith (1979), Foushee and Manos (1981), and other empirical studies in this area are based upon realistic flight simulations, where high levels of crew workload precipitated by carefully controlled events no doubt contributed to the crew performance problems reported herein. These levels of workload and stress are characteristic of many accident scenarios, but they are infrequently encountered in day to day operations. While the results of these studies may be disturbing to some, the remarkable overall safety of the system should be stressed. Fortunately, the problems discussed here rarely lead to accidents, which is a testament to overall system redundancy. It should be comforting to note that since accidents are so infrequent, they make terrible research criteria for judging crew performance, and it is a credit to the industry that the primary research and training concern is upon those aspects of performance which under some circumstances can have dramatic consequences. Attention is now turned to methods aimed at the facilitation of this process.

ADDRESSING THE ISSUE

Hackman and Morris (1975) suggest that the best way to effect meaningful change in group performance is to concentrate on input factors. Thus, it is proposed that group performance strategies can be made more task-appropriate by modifying the group's norms, that member effort and coordination can be increased by task redesign, and that the level and utilization of group member knowledge and skill can be improved by altering the composition of the group.

It was previously noted that the existence of group performance problems is becoming more salient to the air carrier industry. Several airlines, stimulated by this awareness, are beginning to address these issues in their training programs, and one company has made a substantial investment in a comprehensive program of "cockpit

resource management" training for all of its pilots. The remainder of this discussion will focus on some of the techniques utilized in this program, and whether they may be expected to facilitate the group performance process.

Altering Group Norms

Much of the normative structure of professional pilots is well established, having evolved during a time when aviation was not routine and the dangers of flight were considerable. These conditions fostered, largely through self-selection processes, a pilot profile that has been characterized by Tom Wolfe (1979) as "the right stuff." An individual who typifies the right stuff is generally described as a highly goal-oriented, extremely self-reliant, macho, decisive sort; and it is clear that such a profile was functional, if not a prerequisite, for the job in the past. Some would argue that reliance upon others was negatively related to longevity in "the old days." While it is easy to visualize such individuals functioning effectively as fighter or test pilots, it is more difficult to view them as "good team players." In the past, airlines themselves did little to discourage captains from functioning in this manner. The 1952 guidelines for pilot proficiency checks at a major airline explicitly stated that the first officer should not correct errors made by the captain (H. W. Orlady, personnel communication). To this day, the Federal Aviation Regulations governing pilot qualifications deal almost exclusively with the acquisition and maintenance of individual pilot proficiency.

Despite the fact that the aviation environment has changed considerably, these norms are ubiquitous, and an attempt is being made to alter the normative structure of the flightcrew in some training programs. One method employed in an effort to correct certain ineffective task performance strategies, associated with excessive instrumentality, is the use of videotape feedback and diagnosis of task-specific behaviors. In one program, crews are asked to fly a full-mission simulation that is videotaped from start to finish. Following these simulated flights, crewmembers view the tape with an instructor and discuss such aspects of the group process as the effects of interpersonal styles, the appropriate delegation of responsibility, and how the role structure can inhibit the input of subordinate flight crewmembers. From a theoretical standpoint, this approach may very well produce some tangible change. Duval and Wicklund (1972) in their theory of objective self awareness, found that self-focusing manipulations often force objective appraisals of oneself that may lead to attitude and behavior change. Anecdotal evidence from this program is suggestive of a positive impact, with crewmembers expressing surprise at their behavior during the videotaped flights.

Another prevalent technique within the industry is the use of seminars as a means of providing information aimed at altering the normative structure of flightcrews. These seminars are frequently offered as part of the training required for promotion from junior crewmember to captain. The philosophy underlying this approach, as well as other feedback approaches, is that heightened awareness will produce tangible behavior change. It is not presumed that the personality structures of individuals can be altered in a short period of time, but it is felt that the pilot socialization process has not generally produced patterns consistent with teamwork. Thus, it is argued that pilots are often not aware of how subtle factors can compromise group function. The educational content generally places a heavy emphasis on material related to the role of interpersonal styles and the effects of certain types of behavior on co-workers. Group exercises,

personality assessment and feedback techniques, role-playing, case studies, and interpersonal encounter drills, are frequently employed.

It may surprise some to discover that these programs are proving to be popular in airlines that have implemented them, however, serious questions are usually raised as to their long-term effectiveness. It is probably true that these interventions provide short-term insight, but long-term change is no doubt dependent on periodic exposure and reinforcement. Unfortunately, few organizations are providing their personnel with this type of training on a recurrent basis. Perhaps more disturbing is the dearth of research dealing with the evaluation or relative efficacy of such programs. Many principles, which are being "preached as the gospel" in such programs, are in need of further study.

Increasing Member Effort and Coordination

Raising individual member effort and coordinating these efforts is another means of increasing group productivity. One method suggests that restructuring the task, in a way that *requires* coordinated performance from all group members, will dictate increased member effort by necessity and produce normative change. Since flight training has traditionally emphasized individual skills, most pilots have had very little realistic experience with high workload or emergency situations that require teamwork. Moreover, equipment reliability and automation have rendered most flight tasks routine; high stress, emergency situations are relatively rare. Yet, as has been mentioned, this lack of experience may be a factor when crews are faced with non-routine situations; a view which is supported by the incident and accident record.

While it makes little sense to change substantively the task of flying most modern aircraft considering the remarkable safety record of the present system, it may be logical to restructure the training task. Many airlines are beginning to utilize a technique known as Line-Oriented Flight Training (LOFT; e.g. Lauber & Foushee, 1981) in which crews fly a complete trip in a high-fidelity simulator. However, unlike the real world, LOFT scenarios are usually designed to include emergency situations which *require* the coordinated actions of all crewmembers for success. These flights occur in real time, and no intervention is made by the instructor regardless of the actions of the crew. LOFT is a learning experience in which errors are usually made. However, since effective group function in this environment is by definition the management of human error, LOFT provides highly effective crew coordination training. Just as it is necessary to practice landing skills in order to gain and maintain aircraft-handling proficiency, it is necessary to practice crew coordination skills in order to assure good flightcrew performance. LOFT provides the vehicle by which these skills, now recognized as important, are practiced and maintained. Some air carriers provide LOFT training every six or twelve months, and this approach may be a more viable way of producing long-term behavior change.

As Hackman and Morris (1975) suggest, the amount of effort group members put into a task is also heavily affected by the normative structure of the group. It has been noted that factors inherent in the role structure of the flightcrew, while necessary for the effective coordination of responsibilities, sometimes serve to decrease the effort expenditure of subordinate crewmembers. By changing the norms of the group and reinforcing the importance of coordinated performance, the malady some refer to as

"captainitis" may begin to subside, and subordinate crewmembers may find it easier to have sufficient input into the group process. If these programs accomplish nothing else, they may have been beneficial by simply heightening awareness of the importance of leadership styles that encourage the input of all team members. By "legitimizing" this input or making it a part of the group's values, it is reasonable to expect some increase in member motivation, at least in the short-term.

Changing Group Composition

Altering the group's composition may be the most effective, and perhaps the most difficult of means for improving group effectiveness. Yet, it is an inescapable fact that successful group performance is heavily dependent upon the individual skills of members, and efforts aimed at the recruitment of qualified individuals has always been one of the favored means of producing the desired result. There is very little question that most airline pilots are highly skilled in the technical aspects of their job, but there is concern about their function as team members. In the United States, the labor pool is comprised heavily of pilots whose formative years were spent in high performance, single-seat, military aircraft. It has been suggested that pilots with this type of experience may bring an individualistic emphasis to the air carrier cockpit and that learning team member skills can only be accomplished slowly and painfully. One obvious solution would be the selection of individuals for the position of airline pilot who possess the skills associated with good leadership or team function.

For the airline industry, this approach has obvious drawbacks, at least in the near-term. Clearly, it does not address the needs of the present pilot population, since past selection criteria have not encompassed these abilities. Helmreich (1982) has recently reported work with a new airline in which both instrumentality and expressiveness were among the desirable selection criteria for new pilots, but it is too soon to draw any inferences about the success of such selection practices.

CONCLUDING THOUGHTS

The most practical approach for most companies is to focus upon changing pilot attitudes and experiences in this domain. The techniques discussed above such as LOFT, seminars, and feedback are aimed at increasing the skills associated with group function in flight crewmembers through an increasing awareness of the importance of these factors. It should be stressed that this is neither a small task, nor is it a short-term one. The open treatment of issues related to one's interpersonal competence can be, and has been, very anxiety-provoking for some individuals. No matter how well this type of training is conducted, certain people will be resistant to change provoking some critics of these programs to argue that the very individuals who need to improve will not benefit because they are the ones likely to be threatened.

Organizations that have undertaken resource management training programs report that after exposure to this training, peer pressure often facilitates change among those individuals initially unreceptive to the program. At present, training approaches are entirely non-punitive, but some have suggested that the same standard should be

applied to interpersonal competence as is now applied to technical competence. This, of course, implies a wholesale reevaluation of government and industry practices in the training and checking areas. Since these training programs are only beginning to be implemented, and only by a few airlines, we do not know whether they will produce any meaningful or long-lasting benefits. Nonetheless, it would be foolhardy to suggest that better knowledge of these issues, and efforts to provide this knowledge to those who stand to gain, are not a step in the right direction.

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AIRCREW CO-OPERATION IN THE ROYAL AIR FORCE

Wing Commander C. B. Adcock
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INTRODUCTION

In a recent editorial column in Air Clues, Wing Commander Spry drew attention to the fact that the standard of aircrew cooperation has been brought into question by Boards of Inquiry into a number of recent RAF accidents.[1] This trend, however, is not confined merely to the RAF, but reflective of an increasingly significant development in the world-wide operation of multi-crew member aircraft. The United States Air Force, for example, has also been affected, the Military Airlift Command (MAC) in particular having suffered in recent years from a rising incidence of aircraft accidents attributable to inadequate crew co-operation. Nor is this phenomenon an exclusive feature of military operations, since a similar trend can also be discerned in concurrent aircraft accidents sustained by commercial air carriers.[2]

Commenting on the problems affecting RAF operations, Wing Commander Spry went on to say..."The essence of crew co-operation is either up-dated or established during the preparation for flight; in the simulator, flight planning room, and pre-flight briefing. All crew members must be aware of their levels and areas of responsibility and the actions expected of them, both during normal operations and in an emergency. Regular practice followed by a critical debrief is the only foolproof way of getting the act together and ensuring that poor crew co-operation does not compound an emergency situation."[3]

These comments accurately reflect the traditional RAF approach to aircrew co-operation, but American research into recent aircraft accidents has strongly suggested that established ideas and training methods have failed to adapt to an ever-growing demand for greater crew co-operation, and a much more comprehensive approach to the problem is required if errors and accidents caused by lack of crew co-operation are to be reduced. As a result of this research, MAC, together with an increasing number of major U.S. air carriers, is introducing a new form of aircrew training designed specifically to improve crew co-operation on the flight deck. This paper describes the origin and principles of the new training, and suggests how it could improve flight safety in the RAF by preventing accidents caused by lack of crew cooperation.

EDITORS' NOTE: This paper was awarded the Royal Air Force's L.C. Groves Memorial Prize for Aircraft Safety.

[1] Air Clues, Vol 39 No 6, June 1985, p 215

[2] A NASA review and analysis of jet transport accidents worldwide during the period from 1968 to 1976 revealed more than 60 in which breakdowns of crew performance process played a significant role. (See H. Clayton Foushee, "Dyads and Triads at 35,000 Feet, Factors Affecting Group Process and Aircrew Performance, AMERICAN PSYCHOLOGIST, Vol 39, No 8, August 1984, p.885.)

[3] Air Clues, op cit.

Aim

The aim of this paper is to prevent flying accidents in the RAF by improving crew co-operation.

ACCIDENT CHARACTERISTICS

Crew Co-operation

It is highly probable that inadequate crew co-operation has always been a significant factor in accidents involving multi-crewmember aircraft. In the past, however, the critical nature of crew co-operation in determining the course and final outcome of an incident was often overshadowed by technical failures affecting the integrity of the aircraft and its associated systems. Despite the extremely high degree of technical reliability associated with modern aircraft, however, accidents have continued to happen, and there has been a consequent increase in attention on human factors and the crew process. This development has been assisted by the mandatory installation of flight data recorders and cockpit voice recorders which have enabled investigators to shed more light on crew interaction during the events leading to the accident. During the period when these developments have taken place, aircraft have also increased significantly in size, performance and complexity, a development which has placed even greater demands on the ability of the crew to perform their tasks. At the same time, the airspace has become increasingly congested, while the operation of military aircraft has been further complicated by the progressive introduction of increasingly sophisticated defensive systems. These changes in the operational environment have not only made it essential for individual crew members to function effectively as part of a team to accomplish the mission, but also ensured that lack of crew co-operation is likely to have more far-reaching consequences in the present day environment than it might have had in the past.

MAC Accidents

Like the RAF, MAC has suffered recently from a series of incidents and accidents in which lack of crew co-operation has played a significant part. Although no two accidents have occurred in precisely similar circumstances, a common pattern of human fallibility has emerged from the accident investigation process. All the crews were experienced in their particular aircraft type and well-versed in their role. Despite the relatively high competence level of the crew, however, most of the accidents occurred either through a procedural mistake, such as flying into high terrain, or because the aircraft commander pressed on beyond a prudent limit despite the fact that there was no overriding operational reason for him to do so. In almost every case, the accident investigation showed that these failings resulted from a lack of communication, poor crew co-operation, or a complete breakdown of crew discipline in the cockpit. These shortcomings, when exacerbated by adverse circumstances or the abrupt and unexpected imposition of a high cockpit workload, resulted in a fragmentation of the group process and a corresponding and catastrophic decline in crew performance.

U.S. Commercial Aviation Accidents

A breakdown in crew co-operation has also been a critical factor in a high proportion of recent accidents involving U.S. commercial jet aircraft.[4] Experiments conducted by the NASA Ames Research Center have determined that one of the principle causes of these accidents was a failure by the flight crew members to use effectively all of the resources available to them during flight operations.[5] The NASA research team also concluded that, in large part, this failure was due to inadequate training in leadership, command, and cockpit management.[6] These significant findings have led in recent years to a progressive change in airline training methods whereby the traditional emphasis on high levels of individual skill has been supplemented by a positive effort to improve crew effectiveness and group performance.

GROUP PERFORMANCE

Group Skills

The well-documented difficulties experienced by MAC and the U.S. commercial air carriers in the area of crew co-operation suggest that the recent problems encountered in RAF operations are neither unique, nor amenable to easy solution. Notwithstanding the excellent work carried out by NASA and academic institutions in the U.S., the group process by which the crew manages the mission is, at best, only imperfectly understood. Meanwhile, the lack of a sound theory of cockpit management has inhibited the development of effective training in crew co-operation. Most corporate training organizations and all regulatory agencies place a high premium of the development and acquisition of individual knowledge and flying skill, but hardly any formal training is given or required in "group skills". In this context, the term "group skills" refers to the continuous process of communication, interaction, and decision-making through which the crew manages the progress of the flight.

The Group Process

Despite a lack of formal training, most crew members eventually develop through observation and intuition a rudimentary grasp of the group skills necessary to perform effectively in the cockpit. The lack of effective training programs, however, leads to a haphazard and uneven distribution of group skills among individual members of the crew force and leaves many crew members without a real understanding of the interpersonal and group skills they need to perform effectively as members of a team. The absence of formal training also inhibits the spread of ideas and the development of better cockpit management techniques. Furthermore, without the insight that education brings, crew members are unable to articulate or resolve problems relating to poor resource management and lack of co-operation in the cockpit, while the failure to develop a lexicon of group skills hinders the evaluation of individual contributions to the team

[4] H. Clayton Foushee, op cit.

[5] John Lauber, "Resource Management in the Cockpit", Airline Pilot, September, 1984, p 20.

[6] Ibid.

effort and precludes effective remedial action when deficiencies are observed. It has been the identification of these problem areas through research which has led to changes in the traditional approach to aircrew co-operation training in the U.S.

AIRCREW CO-OPERATION TRAINING

Academic Training

A common starting point for all aircrew co-operational training which is currently being carried out in the U.S. is the development of a formal academic program. The purpose of this academic training is to change aircrew attitudes towards co-operation by highlighting the shortcomings and limitations of present training methods and introducing new concepts of group skills. Academic training gives crew members a better understanding of group dynamics and the interactive nature of the decision-making process. It can also demonstrate that effective groups will normally arrive at higher quality decisions on complex problems than an individual acting in isolation--a process known as "synergism". Finally, academic training provides a solid foundation for subsequent practical training in aircrew co-operation.

Academic Training Programs in the U.S.

One of the better-known academic training programs in the U.S. is a Cockpit Resource Management course which was developed for United Airlines by Scientific Methods Incorporated, a Texas-based management consultancy group. The course consist of a three-day seminar-based training program designed to develop effective group skills in aircrew members. To provide a simple but effective starting point for the development of complex ideas on synergism and the group process, the course utilizes a widely-known and well-understood American training concept, the Blake-Mouton managerial grid. Through analyzing their own performance in terms of grid concepts, and by assessing the contributions of other members of the group in a similar way, crew members gain insight into the group process and the development of synergism. Over 5000 United Airlines crew members have now attended the Cockpit Resource Management course, together with many crew members from other airlines and corporate flying organizations who have been trained under contractual arrangements. Several other academic training programs have also been developed in the U.S., but while they may differ in form, content and style, their underlying purpose remains the same as the United Airlines course--that is, to improve crew co-operation by fostering and developing group skills in individual crew members.

Theoretical Training in the RAF

Although RAF aircrews are given general training in management and leadership during their initial induction into the service, there is no subsequent formal program to transform these basic skills into the highly developed group process which is required to perform effectively in a modern, multi-crewmember aircraft In view of the high demands which are now placed on individual crewmembers, and the rising incidence of accidents in which lack of crew co-operation has been a significant factor, there is an urgent need

for the RAF to develop an organic academic program to teach group skills. This training should be given not only to aircraft captains, but to every crew position, so that each individual in the aircraft can relate effectively to the group process. The concept of functional leadership, would make an ideal starting point for an academic training program in aircrew group skills. Appropriate elements of the program should also be written into the basic flying training manuals. The academic phase of aircrew co-operation training should take place during initial aircrew training so that crew members are indoctrinated from the outset in the concept of group skills; it should then be developed and reinforced at appropriate intervals throughout their flying careers. A well-developed academic training program would not only provide greater insight into the concept of group skills, but also provide a solid foundation for subsequent practical training.

Practical Training

Because of the dynamic and transitory nature of group interaction, progress in devising practical training programs in crew co-operation has been relatively slow. The advent of the modern flight simulator, however, has provided a highly suitable environment for training crew members to particate more effectively in the group process. Unfortunately, the limited realism and fidelity of the early simulators obscured their potential for training crew members in group skills, and led to the reinforcement of previous training doctrine based on the development of individual pilot skill (known in the U.S. as "batting practice"). It has been a slow evolutionary process to overcome the "batting practice" mentality associated with simulator training and supplemental programs designed to develop individual skill with the more complex scenarios required to promote group skills.

Mission-Orientated Simulator Training

Following the development and introduction of modern, high-fidelity flight simulators, several U.S. commercial airlines have supplemented their traditional approach to aircrew training with a new program known as Line-Orientated Flight Training (LOFT). Following a comprehensive briefing on the purpose of the exercise, each crew flies a standard route sector in the simulator. During the flight, the crew is presented with several structured problems which can best be solved not in isolation, with each individual crew member acting independently, but through the cooperative effort of the entire crew acting in concert. No assistance in solving the problem is given by the simulator instructor, who merely records the various reactions and responses of members of the crew. Crew actions are also recorded on a videotape, which is used in the debriefing and discussion period which follows the simulator flight to illustrate significant points arising during the mission. As part of the debriefing, the instructor encourages crew members to analyze their own performances and learn about the group process from their collective experience during the training session. The LOFT training program, which has been favorably received by aircrews flying for commercial airlines, has also been suitably adapted to the military environment as Mission-Orientated Simulator Training (MOST). The MOST system is now an integral and successful part of continuation training on all the major MAC weapon systems.

Practical Training in the RAF

Since many RAF multi-crew aircraft are also supported by modern flight simulators, the MOST system could be readily adapted to provide practical training in crew co-operation. The principles of MOST should be introduced at the OCUs during initial conversion to type, and included as an integral part of subsequent continuation and up-grade training. The introduction of MOST would require the research and development of suitable training scenarios and appropriate indoctrination and training for the simulator instructors. However, in view of the relatively small outlay in terms of material and training development, and the potential advantages which improved crew co-operation would bring, the introduction of MOST into the RAF training syllabus would be extremely cost-effective.

Feedback

In addition to theoretical and practical training in aircrew co-operation, an effective system of feedback is also required for a healthy and successful development program. By obtaining feedback through its Aviation Safety Reporting System (ASRS), the NASA Ames Research Center has established a considerable data bank on human factors in the cockpit. Under this system, commercial aviation pilots are encouraged to report human errors through a guarantee of anonymity and immunity from disciplinary action. Data from ASRS is used to facilitate research into the cockpit group process. MAC, too, has an "Accident Waiting to Happen" (AWTH) reporting system similar to ASRS, which also provides useful data on human factors in the military cockpit. In the same way, the RAF's own confidential flight safety reporting system, "CONDOR", could be readily used in conjunction with the normal flight evaluation process to support a crew co-operation training program.

MOTIVATION AND MORALE

Risk-Taking

The lack of balance between the emphasis on individual skill and the need for group skills, which is a feature of aircrew training in the RAF today, not only increases the risk of flying accidents by inhibiting crew from achieving maximum cohesion and effectiveness, but produces other adverse side effects as well. Since individual crew members seek job satisfaction and personal development through the acquisition of professional knowledge and skill and gain self-esteem and fulfillment from the approbation of their peers, they are likely to turn to risk-taking and "press-on-itis" to seek recognition and reward if too much emphasis is placed on the attainment of individual skill. In extreme circumstances, a natural desire for enhanced self-esteem can result in the suspension of prudent judgement and induce crew members to attempt maneuvers which are either beyond their level of skill or outside the safe operational limits of the aircraft. This phenomenon has been well documented by past RAF boards of inquiry into aircraft accidents.

Job Satisfaction

Lack of proper emphasis on group skills at all levels in a crew member's chain-of-command also inhibits the achievement of job satisfaction through a meaningful contribution to the team effort. Inability to participate effectively in the group process leads to frustration, poor motivation, and a progressive decline in morale. By adversely affecting motivation, these factors have a significant impact on retention rates, an area presently of considerable concern to the RAF. Conversely, a positive training program in group skills would not only reduce aircraft accidents by improving crew co-operation, but also have a highly beneficial effect on motivation and morale.

CONCLUSION

The progressive introduction of modern, high-performance aircraft, coupled with a significant increase in the complexity of the operational environment, has highlighted crew co-operation as a critical factor in aircraft safety. Investigation into recent MAC aircraft accidents supports the conclusion reached by NASA and other U.S. research institutions that a positive training program is required to improve resource management in the cockpit and prevent a breakdown under stress of the crew process. Past training and regulation has concentrated on the attainment of individual flying skills, but group skills have been neglected through lack of knowledge and understanding of the group process. This long-standing deficiency is now being addressed in the U.S. by the progressive and widespread introduction of theoretical and practical training programs to improve crew co-operation. The RAF should provide similar training for its aircrews through the adaptation and development of existing training resources. Better crew co-operation would not only reduce the number of RAF aircraft accidents but also improve the morale of the Service.

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CRM AND HUMAN FACTORS TRAINING: WHAT AIR NEW ZEALAND IS DOING ABOUT IT[1]

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BACKGROUND

The authors of this paper have played an integral role in Air New Zealand's evaluation of CRM and Human Factors training options available to date. As the final decision as to which course is best suited to Air New Zealand's needs has yet to be made, this paper will briefly outline: 1) why this form of training was considered necessary; 2) the approach taken to evaluating the options available; 3) some of the problems encountered on the way; and 4) some plans for the future.

OVERVIEW

Along with many other airlines, Air New Zealand recognized human factors as the major cause of aviation accidents and incidents worldwide. Feedback from our own Flight Safety Committee together with information from other operators suggested that the training offered by CRM and Human Factors courses was necessary in terms of accident prevention, and to further enhance the standard of operation. The problem that soon became apparent with the number and variety of courses offered, was which one would be most suitable for Air New Zealand aircrew?

Over two years have past since members of the Flight Safety Committee were first given the task of evaluating the types of training available. Other personnel have become involved, including a professional aviation psychologist. The approach taken was to experience and report back on each of the courses and to this end, Flight Operations personnel have attended United's CRM program, the Quantas Human Relations Training program, Ansett Airlines of Australia KHUFAC program (the human factors training program developed by KLM), and Trans Australia Airlines (TAA) Aircrew Team Management (ATM) training program. Also attended were the more in-depth Human Factors in Transport Aircraft Operation (HFTAQ) course offered by Captain F. Hawkins (KLM) and Professor E. Edwards[2] and conferences (such as that sponsored by Ohio State University in 1985), where this type of training was discussed.

[1] Any queries regarding points raised in this paper can be addressed to the authors: Air New Zealand, Private Bag, Auckland, New Zealand.

[2] This course was held in Australia in 1985. It was sponsored by Ansett Airlines, and was similar in format to that conducted by the University of Aston in England.

Many problems were encountered during this time, and those with relevance to other airlines are reported here. Two of the biggest problems can be put together under the heading of line pilot acceptance. Resistance to change and resistance to jargon have plagued, and will continue to plague, the evaluation and implementation of this type of training. Likewise cynicism and skepticism have been, and will continue to be, encountered. These attitudes are now viewed as normal, and more importantly, as a necessary requirement for demonstrating attitude change. Working in an environment where these attitudes prevail, however, is potentially unrewarding for proponents of Human Factors or CRM training.

Another problem encountered involves the sometimes unexpected and often dramatic *cultural differences* in *how* the training is given. For the average Air New Zealand pilot (if such a pilot exists) there appears to be a resistance to the North American approach, and, to a lesser extent, the Australian approach. This resistance may stem from a more conservative education/schooling system in New Zealand. Any course contemplated needs to be modified in-house in order for it to be suitable in this regard.

Economic pressures are also a problem. Finding additional training days is becoming increasingly difficult, and there is pressure to fit a new training package into the existing system. Encouragement has been received, however, by the regulatory authorities and airline management who see the need for a review of current training time allocation. It is almost inevitable that once this form of training is considered, that existing training philosophy and requirements are re-examined.

Another major problem that exists is the *long-term needs*. In the short-term, the flight-deck orientation of some of the courses offered suits the immediate needs and concerns of Air New Zealand aircrew. There is a need, however, for the industry to provide training in those Human Factors areas which are not (or more appropriately have not been in the past) addressed by the education/schooling system.

The authors of this report are now in the position to recommend the type of training which is most suited to Air New Zealand. Following the purchase of a flight-deck oriented package currently available, there will be a need for in-house modification prior to implementation. It is expected that the regulatory authorities (Civil Aviation Division of the Ministry of Transport, NZ) and the Airline Pilots Association will have an input, along with individual aircrew who may wish to become more involved in the initial modification phase. Promotion of the course to line pilots will also be important at this time.

Following the modification phase, the first course to line pilots (other than a train-the-trainer course), will be given to a cross-section of aircrew. Priority in attendance would be given to new-hires, pilots undergoing command training and/or type change, and line superintendents and instructors. Pilots who are "stable on type" would have the lowest priority initially.

Each successive course would be reviewed and evaluated by both participants and course presenters. Effectiveness of the training will also be monitored, using both objective and subjective methods. Ongoing research will consider a standardized

approach to LOFT across all fleets and the development of a refresher training package. As previously noted, there may be a need in the future to supplement a course of the type recommended with a broad-based Human Factors education program.

Information obtained at this conference, especially with regard to the implementation and effectiveness of CRM/Human Factor training, will play an important part in the final evaluative step taken by Air New Zealand.

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COCKPIT RESOURCE MANAGEMENT AT USAIR

Dr. Robert Sellards
USAir

This paper deals with the current USAir CRM program and combines the lessons learned and the program issues.

CURRICULUM

The training material was developed after an extensive literature search and pilot interview survey to determine the problem. The USAir program began in 1979. The *problem* was identified as a large number of accidents involving the "human factor" and "human performance/interaction" as key variables. This problem was not unique to any one airline but to the whole industry, including the military. There is much research to identify the issue and I will not cover that data at this time--suffice it to say that extensive research was done to ensure there was a problem with a pilot's behavior and the interaction with the environment, or another person, in a negative manner, and the result was a loss of life.

The investigation led to the *design, implementation, and evaluation* of a behavioral science awareness training program. The need was found, and the *target population* was identified as the pilot group.

Problems in the human factor interface with accidents were identified which impacted on curriculum selection. Some of these were fatigue, boredom, disorientation, preoccupation with personal problems, attitudes, misreading instruments, interpersonal communication with crew members, misunderstanding communication at all levels, language barriers, judgement, decision-making, personal pathology, lack of assertiveness, incorrect assumptions, authority problems, trust of crew members, discipline, leadership, role dilemmas, inadequate planning, workload, equipment interaction, physical and psychological stress, and many more. The resultant research came up with a two and a three day program (depending on training days available).

The program has been evaluated and reevaluated over time. A *research survey* instrument is used at the beginning of each session to evaluate the amount of knowledge a pilot has about each subject presented. The instrument also calls for each pilot to give input on problems encountered, expected, whether the pilot feels a need for training, and what that training should include. Another instrument has been utilized at the end of each session (all surveys are anonymous) to evaluate the pilots perception of the training and its effectiveness. This material is used to constantly add or subtract subjects as feedback dictates.

In 1985 a survey was sent to graduates who received training in the 1980-1982 time-frame to obtain feedback on *applicability, effectiveness, and retainability* of subject matter. This research is ongoing and will be mentioned later. This feedback has also

dictated curriculum changes.

The intent of the program has been guided by the fact that the pilot who has the accident/incident (pilot error) is someone who has either:

- o Personality problems and/or pathology,
- o Interpersonal skill/communication problems,
- o Inability to control environmental variables for whatever reason, or
- o Physical problems.

This is keeping in mind the fact that the technical malfunction of the aircraft may or may not be separate from these identified problem areas. The long laundry-list of problems will fall under these categories in some way.

All of the above mentioned issues and research guided the curriculum to include the following subjects:

1. Incident/accident case studies.
2. Personality theories.
3. Leadership theories.
4. Stress self-assessment tests.
5. Leadership assessment tests.
6. Human development theories.
7. Personality profile inventory tests.
8. Substance abuse.
9. ASRS, NASA, NTSB, and FAA data discussions.
10. Captain, FO, Engr. and other crew roles.
11. Diet, sleep, circadian factors, and physiology assessment.

Some other very important components of the curriculum are discussions on the following subjects:

1. Internally-/externally-driven individuals.
2. Personality/attitude discussions.
3. Technical/non-technical pilot training.
4. "Left/right brain" personality studies.
5. Subtle incapacitation.
6. Cognitive dissonance.
7. Psychosomatic studies.
8. Circadian studies.
9. Sleep research.
10. Behavior modification.
11. Personality types (how to deal with various types).
12. Family/marital and child-raising problems and techniques.

The research over the past 6 years supports the curriculum. This is, of course, a

very brief overview, but does give the flavor of the program.

TECHNIQUES FOR CRM

The education/training should start in the classroom as it does for all professionals. Research is very clear that one must grasp the principles of the subject matter for it to be effective in the long range. The application of the education to the job will occur in a number of ways. There must of course be a "leap" made from education and theory to the real world of flying. One must make this type of leap every day in all sorts of ways. Pilot education has been overloaded in the technical flying area and largely lacking in the behavioral science field. CRM must use techniques other than rote memory or "left brain"-oriented tests and exercises. There is no cookbook answer or manual to cover every possible accident scenario. Hence, the pilot must possess skills (and be taught them) to identify human factors as they pertain to accidents. The pilot must be able to determine the "warning lights" of problem behavior as they occur with a fellow crew member or himself. This is one of the ways we can avoid the human factor accident. A crewmember who doesn't know how to assert himself/herself, for example, may die and kill others in an accident due to never knowing how to send a strong "I message." It has happened. The crewmember who cannot recognize problem behavioral clues given by a fellow pilot will also die due to a lack of education and sadly kills others too. These human factor variables can be taught and must be taught in the classroom where discussion is allowed in a non-threatening manner. This is the way the professional psychiatrist, psychologist, social worker, or counselor is taught. There is no other proper way to start the process correctly. Documented educational research is very clear in this matter. The pilot then must take this classroom knowledge to the cockpit or home situation and apply it there.

Statistically-valid and reliable tests should be used. Pilots are individuals who like facts, data, and numbers in a logical sequence. They need proof. The tests give them that type of feedback and open the door for personality/attitude change as needed.

LOFT [-type exercises] do not have to occur in the simulator. LOFT [-type exercises] and simulator do not need to be synonymous. This is too narrow a definition*. The simulator may be a natural follow-up to the classrooom education but may not be necessary in all cases if on-going classroom education were utilized and reinforced. If a pilot cannot make the educational leap from behavioral science education in the classroom to the cockpit, then I would submit we have a potentially dangerous pilot in regard to the human factor issue and accidents.

There may even be a danger to use of simulator situations and human behavior because it reinforces the need for structure when in reality there is no cookbook structured situation that applies in all scenarios. If too much "spoon feeding" of the material is done we may not be conditioning pilots to expect and be prepared for the unexpected. Ideally though, the simulator is an excellent classroom if needed and the

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*EDITORS' NOTE: The acronym LOFT (Line-Oriented Flight Training), as commonly used in the industry and described in Federal Aviation Administration Advisory Circular 120-35, refers to the use of a high-fidelity training simulator to conduct simulated line operations for training purposes.

"right exercises" are introduced.

This constant mentality of having to have structured training may be adding to the problem at times. Dependence upon structure and the idea that if you do not have written rules or structure you can't control or govern something may be fallacious. It may also be why we have no mandated training even though the problem of "pilot error" and research in this area has been with us for the past 20 years. The research supports *recurrent classroom instruction* to reinforce theories and principles and then utilize personal experience discussions to heighten cognitive awareness of accident factors.

The *group situation* is most helpful in identifying and experiencing group interaction variables. The pilot is in the group (15 to 20 members) and is educated on group principles/theories. Being a member also allows experimenting with new behavior as well as identification with the many individual issues discussed. The *group feedback* is most helpful as it helps motivate and modify behavior much better than one-on-one situations. Research on groups and their benefit in changing behaviors is extensive.

I would add that the training does not have to be expensive and involve simulators at the onset. One well-chosen, educated, experienced teacher could deal with a student group of 15-20. This would include didactic material and extensive discussion. The second step would be the simulator or a reinforcement in the classroom within a year or so, with follow-up material by mail. Material could also be mailed prior to a classroom structure.

INTEGRATION INTO THE TOTAL TRAINING CURRICULUM

For maximum effectiveness the training should be reinforced at least yearly. Research into the USAir program does show 5-year retainability of some portions of the training, but much data asks for more follow-up--even for 6-month recurrent. The research documents that some *tangible and lasting behavior change* did occur in the *two- or three-day* period training time. We also have at least two documented experiences where pilots have stated that the training saved two accidents and potentially 300 lives.

The National Training Laboratories (NTL) and others have been offering courses of two- or three-day duration in a variety of formats for the past 30 years. They have extensive research to document *lasting change occurring* during and after these sessions.

Remedial training should be utilized and has been in this program. It has not been identified as such, but has been done. Ideally, the feeling is that "accident-prone" (or pilots exhibiting pathology) should be taken off the line, given training, and a series of neurological/psychological tests. If no progress is made then the individual should not be allowed to fly again and kill him/herself and others.

EFFECTIVENESS OF CRM TRAINING

To begin with, the initial reaction from the pilot after training should be positive. The target pilot group is an intelligent, aware population. The rationale for the training should be acceptable to the individual who is also rational. A number of research issues on follow-up have surfaced which pilots have identified as being key to long-term effective programs.

The research extends back to 1980 for this program. Overall, our initial pre-class survey indicates 2 percent of the pilots felt the training unnecessary. Post-class survey instruments show a 4.75 rating (on a 1 to 5 scale with 5 being maximum) overall on all subjects. The five-year follow-up survey data is still being processed. Some of the information has been presented previously, and more will be presented when the data is "crunched." Initially the data does show a definite need for reinforcement through recurrent training. It also shows an identified need for some type of training to be done with family members, spouses, and other employees, as well as accident/incident/hijack victims. It does show more retainability of the subject matter than expected.

What follows is a list of clinical issues that needs to be considered in any CRM program. I have been involved in the instructional aspect, as well as practical application on the clinical side while a US Army Medical Department Officer in Vietnam flying "dustoff." My research dates back to 1970.

CLINICAL ISSUES IN PILOT HUMAN FACTOR TRAINING

The following issues are presented in a smorgasbord-type format to identify them as keys to an effective CRM program. I am making an educated judgment based on research that the pilot who is most likely to have an accident can be identified with a degree of certainty. That pilot may never have an accident due to never being placed in a situation where all the variables lead to an accident situation. However at some time the regression to the mean statistical theory may apply. My research indicates the problem pilot can and should be identified through standardized psychological and physiological tests, peer review, and past incidents.

You change behavior through: 1) behavior therapies; 2) cognitive insight; and 3) psychoanalytic techniques.

Pilots who exhibit excessive insistent demands on others are exhibiting neurotic/distorted behavior initiated by extreme insecurity and are exhibiting "warning lights" that should be heeded. Many pilots prefer to remain where they are and are not interested in altering behavior except in times of crisis or stress.

The pilot can be obsessional where anxiety/distress comes from unrealizable demands that a person be perfect and beyond human limitations. The recognition of weakness and fallibility produces anxiety, which may lead that person to seek help. This may be brought about by cognitive awareness. It is tough for a pilot (problem pilot) to change because some aspects of their life are beyond their conscious control and influence. The group classroom experience provides intellectual/emotional insight. There is a need to interrupt impulsive, destructive behavior and correct some confusion. The

program must give the potential problem pilot some insight which may cause change to occur.

Pilots need to talk it out rather than act it out. They need to understand that there are impediments (perhaps neurotic obstacles) in their living. They need to interrupt impulsive destructive behavior. They must alter responses that are derived from conditioning process.

I have seen many problem pilots who are very defensive on intellectual and emotional issues and this makes them very confused. The confusion leads them to be very rigid and overly stable in their behavior patterns. The captain-upgrade process from right to left seat and the new computers in the cockpit are two examples. Another prime example is the introducing of behavioral science information into pilot training. There is a need to understand and grasp factors such as:

o How and why a person came to be that way.

o How the present way is maladaptive and unsatisfactory.

o How to alter without giving up valid goals/ideals.

The training program must identify many of these issues as there is no certainty they will be brought out in any other way. Most pilots will not seek psychiatric help. We cannot wait for ideal circumstances because they may never occur. We do have a certain number of pilots flying who in many cases have been identified by peers and others who are just "accidents waiting to happen." A program should help identify those individuals.

If a person's capacity for decisive action is interfered with by compulsive need to behave otherwise, then it may take much persuasion and/or encouragement to change. Many potential problem pilots employ intellectualizing, philosophizing, and conceptual thinking (not specific) to defeat understanding. It is tough to focus on concrete issues when a person's defense insists on generalizations, or when they are concrete to such a degree as to destroy the value of the observation. We must overcome compulsion that is of such rigid resolve and teach some type of abandon of resolve so that a person can behave in some random, unplanned fashion to avoid the accident which will also come in some random unplanned manner. The training must present a view of a person's behavior and its consequences. The person has more freedom to explore different or more useful patterns of reacting only when he/she recognizes rigid patterns are not necessary and may cause accidents.

At times, the pilot world is one of excesses of a compulsive power-oriented, activity-dominated culture/system. The person in this system feels he can do anything, succeed at anything if only one wishes, and the possibility of achievement and fulfillment is limited only by one's desires and capacity for work. Insufficient account is taken of physiological and existential barriers and limits to man's capabilities and man's mortality. This might be especially true when applied to aging and its physiological accompaniments--especially for an older pilot who has no other options than flying. At times, the pilot must be able to remove himself from doing and producing. This will divest him from the compulsive need to perform all the time especially and importantly

if this is dysfunctional behavior in the cockpit.

Pilot morale affects all aspects of his/her functioning. Feeling down for whatever reason (bad check-ride) may lead to apathy and other dysphoric emotions and then on to low self-confidence. A program should try to create and maintain a helping relationship characterized by respect, interest, understanding, tact, maturity, and firm belief and ability to help that troubled pilot and teach other pilots to be aware of the danger signals (warning lights of dysfunctional behavior). The program should offer:

- o Suggestions (persuasion)
- o Encouragement of open communication, self-scrutiny and honesty
- o Interpretations of "unconscious material" such as self-defeating behavior
- o Examples of maturity such as the ability, capacity and willingness to profit from experience

There is no one way specific behavior change takes place but rather a number of ways and contexts in which it is facilitated. The CRM program must teach this fact and include some examples of various programs. It should also be stressed that there are formal and informal treatment methods.

There are seasons for everything in life and pilots need to understand this, via perhaps, a lesson in Erikson's eight stages of life. We want to encourage different outlooks on themselves, others, and the surrounding world. This tends to help one cope better with a variety of personal and social problems that arise at home and in the cockpit. This allows one to be more "un-upsettable" when confronted with a new set of troublesome conditions in either setting. Then when the "catastrophes" occur, they do not "awfulize," whine, or grandiosely command in a negative way.

It must be recognized that philosophic or cognitive change remains a prerequisite to basic personality change. This too must be kept in mind in CRM program design. Behavioral change, then, partly and significantly depends on realization that one can learn new ways. Without this cognitive awareness an enormous degree of resistance and inertia tends to occur and may lead to the accident. Self-assessment tests help through cognitive review of a number of different areas that fit in with stress and/or personality disorder. Conceptions and misconceptions are learned and hence, can be unlearned.

The above thoughts are gathered from clinical experience with pilots over the past 10 years. I feel they should have some bearing on curriculum design in an effort to prevent unnecessary human behavior which leads to accidents and loss of life. These thoughts and ideas are by no means completely discussed. They have been a factor in USAir CRM program design.

MILITARY APPLICATIONS OF CRM*
Working Group VI

Col. Timothy H. Hatch, Chair
David R. Nelson, Vice-Chair

INTRODUCTION

The objective of the working group on Military Applications of Cockpit Resource Management (CRM) Training was to examine current CRM training concepts and their applicability to the military environment. It is well known that the military environment presents unique challenges that must be addressed. Among the challenges are the interaction of the military rank structure and the flight deck command structure (which are often independent), officer-enlisted relationships, operational differences (e.g. tactical operations), crew experience levels, high crew-turnover rates, differing crew lifestyles and duties, scheduling irregularities, long crew-duty days, customs and courtesies, mission purpose and endemic problems to include command pressures, inadequate support, job satisfaction and salary. The task of the working group was to develop recommendations addressing specific military needs. Areas considered were curriculum development, CRM training techniques, effectiveness of CRM training and integration of CRM training into the total training curriculum. As these areas were considered, the group made an on-going assessment of the strengths and weaknesses of the current CRM training when applied to the special needs and characteristics of military operations. The group was well qualified to fulfill its intended purpose. It consisted of a good blend of military and civilian, different branches of service (Army and Air Force), major air commands (MAC, SAC, and ATC) and levels of responsibility (ranging from headquarters USAF level to unit level). This report will discuss the what and how of military CRM training and conclude with recommendations on CRM training for military operations.

DISCUSSION

Opening discussion centered on MAC's position and philosophy concerning CRM training. This discussion served as an education and reinforcement about one military application of CRM principles. Before proceeding to the chore at hand to determine the what and how of military CRM training, the group discussed the difference between military and civilian environments. All differences listed in the introduction of this report were discussed and agreement was reached that the differences must be dealt with in the military's CRM training.

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* This is an expanded version of the oral report which appeared on p. 241.

Essential Elements of Military CRM Training

The key term in generating the essential elements of an optimum military CRM training syllabus is resource management. The term resource management is defined as using *all* resources to bring about safe airplane operations with resources used in the broadest sense to mean that both external and internal to the cockpit. An additional key factor is that the training must be crew-oriented dealing with all members of the crew, not just the pilots. The global goals of the training should satisfy command demands and maximize safety. Goals are a joint responsibility requiring a coordinated effort. Objectives to satisfy these goals must focus on the often-cited management skills. These skills deal with leadership, followership, communication, problem solving and stress management. The crew's abilities to function as a team and maintain situational awareness are also critical elements of the program.

The overall training objective is to make all crewmembers aware of proper behavior. This awareness is developed in two ways. First, a model for proper behavior is created and presented. Second, improper behavior must be demonstrated. Next, the program must teach small group dynamics to include leadership, followship, communication skills and the synergy of good team play. All crewmembers must become aware that they do not operate in a vacuum and that they must use their individual talents to form a functioning crew unit. Crew coordination to include problem solving, decision making, task assignment and conflict resolution plays a significant role in developing proper situational awareness.

The military CRM training must be critiqued but not graded. It is important for the crew to share feedback (both good and bad) at the end of training. The goal of this critique is to reinforce the good and correct the bad.

Techniques for Military CRM Training

The group objective concerning the "how to" of military CRM training was to reach the needed balance between techniques that supply information and those techniques that provide experience regarding the trainees own behavior when working with others in the cockpit. The driving principles are: make the training military-specific tailored to the trainee's unit mission; ensure that instructors are properly selected, well-trained and motivated to purpose; and that the training program content is consistent with command philosophy. The training must accomplish three things. First, the trainee must be motivated, provided a conceptual framework and involved in the training. Second, the trainee's knowledge base must be built. This base must include an understanding of the CRM process and the establishment of a common language. Third, CRM skills must be acquired and retained. The objective here is the optimum use of ail cockpit resources. This process must enhance existing skills, build new skills and retain and reinforce skills. Techniques should include classroom instruction, role playing, interpersonal relationships, group problem solving, video tape feedback and LOFT type scenarios. The user must be involved in military CRM training to ensure that the training is tailored to needs. Three steps must be performed early in training program. The steps are: first, conduct a user critical requirements analysis. Second, conduct a user review. Third, conduct user acceptance testing. When these steps are properly conducted, user involvement is ensured.

Implementation of Military CRM Training

Planning for CRM training implementation is critical. The plan must be well thought out and existing training forums should be used to the maximum extent possible. Because this training is not a "one time shot", close attention must be given to reinforcement training. Equally important is the integration of CRM training into the total training curriculum. Military CRM training should begin very early in the crewmember's training. The recommended beginning point is at the end of UPT, UNT, basic flight engineer school, etc. An introductory seminar would probably fill the bill of an introduction to CRM training. Next, each major air command should teach the initial CRM course at their formal schools (CCTS). The CRM course should be taught at or near the conclusion of the formal transition course. To provide reinforcement, formal CRM training should be integrated as a part of annual simulator training. Additionally, for those who conduct semi-annual simulator training (such as MAC), CRM training should be included. When possible, reinforcement should be conducted using video tape and reading materials on at least a monthly basis. In summary, CRM training should be conducted as part of initial training and then reinforced at every opportunity using available forums. Simulators and cockpit procedures and trainers (if available) are a must. CRM training sessions should be recorded on video tape to be used in self-critique.

Effectiveness of Military CRM Training

While not within the specific group charter, the group felt that some statements on effectiveness would be appropriate. Just as with civilian CRM training, there is little to go on to determine the effectiveness of military CRM training. MAC has the only Air Force program in existence, and the program results look good. However, the data are limited and certainly inconclusive. A real need exists for a data base benchmark so that effectiveness can be measured. A neutral agency such as NASA is a prime contender to develop such a data base. Until better means are devised, each using organization should evaluate their own program to determine if the desired results are achieved. All should be aware that barriers to effective CRM do exist. Among these barriers are: the "not invented here syndrome," resistance to change, a belief that such training already exists, and inadequate command support. Our conclusion is that military CRM training will contribute to effective team performance thereby enhancing safe, orderly, and expeditious mission accomplishment to the extent that such training is user sensitive and decidedly military.

RECOMMENDATIONS

The group voiced unanimous support for a strong and credible military CRM training program that trains all aircrew members. The following recommendations are offered concerning such a program.

o The entire military aviation community must be educated on the benefits of CRM.

o The CRM training must start in Air Training Command, continue in each command formal school training and be reinforced at least annually as part of simulator training.

o The program must be decidedly military and sensitive to all military requirements.

o The users must be involved in the training program development to ensure all unique requirements are me

o Continual command support for the training is a must.

o Trainees must be provided feedback from video tapes and self-critique. Formal checkrides should be avoided.

No formal recommendations are offered on the "what and how" of the training program. Because each program must be tailored to user requirements, those areas discussed earlier in this report should be used as guidelines for program development.

In conclusion, each member of the working group expressed the value of this forum and voiced hope and strong support for a tailored military CRM training program.

Report Documentation Page

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16. Abstract

Cockpit Resource Management Training is a relatively new concept in the aviation industry. Although it is still in the process of maturing, it has received widespread acceptance in all facets of the community, worldwide.

NASA sponsored the first workshop on this subject in 1979. That workshop was a direct outgrowth of research begun in the mid-seventies at the NASA-Ames Research Center's Man-Vehicle Systems Research Division (now the Aerospace Human Factors Research Division). This work, under the leadership of Drs. Charles E. Billings and John K. Lauber along with George E. Cooper, Ames' former Chief Test Pilot, was aimed at addressing some of the more perplexing problems underlying so-called "pilot error" accidents that seemed to account for an unusually large percentage of the total. One of the early observations of this research was that many of these problems had nothing to do with "stick-and-rudder" skills, but seemed to be related to other areas, such as decision-making, crew coordination, command, leadership, and communications skills. Another observation was that pilot training programs scarcely touched upon these concepts.

The 1979 workshop included presentations from a broad spectrum of the industry and stimulated the development of a number of training programs. The proceedings document of that workshop (Cooper, White, & Lauber, 1979; NASA Conference Publication 2120) has sometimes been referred to as "the bible" of Cockpit Resource Management Training. Much has happened in this area since 1979, and NASA-Ames' Aerospace Human Factors Research Division has received many requests over the years to sponsor a new workshop to review the progress that has been made. The U.S. Air Force Military Airlift Command, having undertaken resource management training on a large scale, also urged a comprehensive review and agreed to co-sponsor this workshop.

This volume is an up-to-date reference for use by those interested in the subject of Cockpit Resource Management Training. It is a complete proceedings of the new workshop and intended to be the "new testament" for this important training concept.

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